SCIENTIFIC AMERICAN SUPPLEMENT. No. 1402

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Scientific American Supplement, Vol. LIV, No. 1402. NEW YORK, NOVEMBER 15, 1902. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE SUBWAY INCLINE AT NOLLENDORF PLATZ

THE ELEVATED STATION AT BULOWSTRASSE.

THE BERLIN UNDERGROUND AND ELEVATED RAILWAY.—III.

[Concluded from SUPPLEMENT No. 1401, page 22447.]

THE UNDERGROUND AND ELEVATED ELECTRIC RAILWAY IN BERLIN—NOW COMPLETED AND IN OPERATION.*

By FRANK C. PERKINS.

ABOUT twenty years ago, after Siemens & Halske had found it impossible to gain permission to install an electric railway through Friedrichstrasse, they applied for the right to build a line in Markgrafenstrasse to Junkerstrasse, but were also denied the privilege. Later a trial road was constructed from Kadetten-Haus to the Anstalt Railway station in Lichterfeld, and finally in 1891 they submitted a proposition for a city elevated railway to run from east to west. It was designed to run from the station of the State Railway at Warschauerstrasse to the Zoological Garden as well as to Charlottenburg and Grunewald. The opposition was finally overcome, and in 1893 permission was granted for the construction of the line.

The total length of the underground and elevated railway is less than a dozen miles, and the distance from the Warsaw Bridge to the Zoological Garden is about 7 miles. The concession for ninety years was granted by the Police President of Berlin about the middle of March, 1896, and work was started about the 10th of September of the same year.

The elevated and underground road is now in operation, and is giving entire satisfaction to the public as well as the owners of the line. Much attention has been paid to the question of vibration on this elevated structure. A pumice-stone cement and gravel have been used to deaden the sound. The rails are placed on the girders of the structure without the use of sleepers, the distance being 1.5 meters, and the rails are therefore heavier in construction, being 0.18 meter high and weighing 43 kilogrammes per meter.

Much of this overhead construction required masterly engineering skill, especially where passing Potsdamer Bahnhof over streets, canal and railroads. It will be noted by the accompanying illustrations that the elevated portions of this road are constructed on uprights which are free to swing, being set in globular foundation shoes.

Some of the spans, as indicated at the crossing at Grossbeeren Brücke and at the viaduct at Halleschen Ufer, are more than 100 feet long, and in two places the road runs directly through two houses, one of which is known as the "Slit House."

From the first station at Warschauer Bridge, which is the present eastern terminus, to the station at Stralauer Gate, measures 351 yards, while from the latter to the next stop at Schlesisches Gate the distance is 495 yards. The next five overhead stations are at Oranien Street, Kottbuser Street, Prinzen Street, Hallesches Gate and Möckern Bridge. These stops are from 606 yards to 1,120 yards apart and the distance from Möckern Bridge to Buelow Street is 1,665 yards.

The stone arches of the overhead construction together comprise 1,026 yards, while the steel viaducts and bridges cover a distance of 7,960 yards. One of the conditions of the Berlin authorities was that the overhead viaducts were to have a clear headroom of 15 feet above the road level at all street crossings.

It will be noted from the accompanying illustrations that much care and attention was given to the architectural design of the overhead stations, no two of which seem to be the same. The platforms are arranged on the same level with the floors of the cars, one platform being provided for trains in each direction. They are about 250 feet long and covered for more than half their length, while all of the stairways are covered. There are no waiting rooms or wash rooms, and the elevated portion of the station consists simply of a hall, staircases and ticket-distributing devices.

The elevated railway structure has two tracks throughout of standard gage, 1,435 meters, the up and down track being 3 meters apart. The smallest radius of curves is about 80 meters and the heaviest gradient 1:38, except at the Nollendorf Place. The rails are of very heavy construction and lapped joints are used instead of butt joints, the Haarman type being decided upon as the best for the particular purpose. There are two sizes of rails employed. The heavier size weighs 86 pounds per yards and measures somewhat more than half a foot in height. These rails are about 40 feet long and are bonded and cross-bonded for use as return conductors for the current to the power house.

The main girders of the overhead structure are 3.5 meters apart under the tracks and are alternately free suspension girders and cantilever girders. The two cantilever girders are connected together with their four columns into one structure, braced on every side, while the free girders are arranged between the projecting arms of the cantilever girders and are connected by pivoted joints.

THE UNDERGROUND TUNNEL AND STATIONS.

The road descends 13 feet below the surface from the junction of the line, first passing over a bridge spanning the Landwehr canal, and then running down to the Droschken Platz at the Potsdam railroad station.

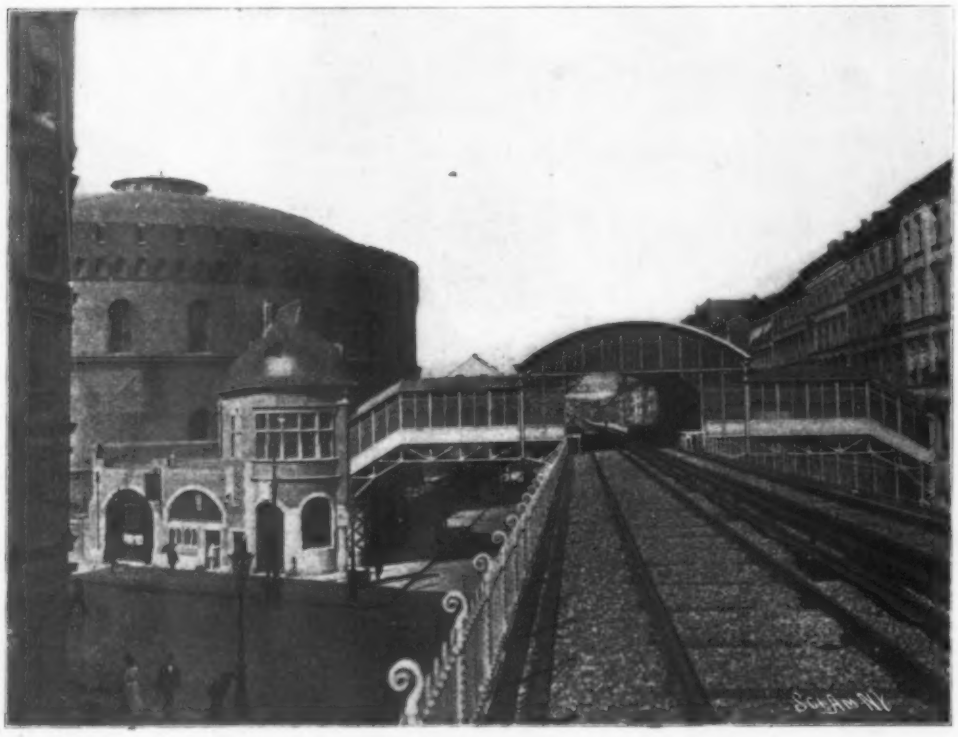
The underground tunnels were excavated in the main streets and the subways constructed, concrete arches 8½ inches thick at the crown being used. The surface of the street is two feet above the top of the arch. The distance between the transverse girders is about 5 feet, the rise of the arch 8 inches, and the total width of the subway is 21 feet 3 inches.

Water-tight asphalt sheathing and cement is used in the trenches, side walls and ceiling, which insures a dry subway. The floor of the tunnel consists of concrete about 3 feet thick, and the rails have a gage of 4 feet 8 inches, which is standard for both underground and overhead lines.

Iron pillars are used as supports between the tracks on account of the width of the tunnel. The underground portion of the line starts at the west of the city, north of Charlottenburg, near the Zoological Garden, and terminates at Nollendorf Place. The tunnel has retreats or niches in the walls about 75 feet apart, and the subway is drained by means of a culvert in the center of each track, and at the lowest point the water is pumped into the main city sewers. The inclines from the tunnels to the viaducts have slopes of 1:38, the viaducts being 50 feet above the tunnel.

The underground terminus station of the branch line is at Potsdamer Square, and the overhead station at Buelow Street is 2,100 yards away, while the next station is at Nollendorf Square, 682 yards farther. The underground station at Wittenberg Square is 893 yards from Nollendorf, and the terminal underground station is 965 yards farther west at the Zoological Gardens.

The total length of the tunnel is 1,856 yards, and the tunnel approaches or inclines are 622 yards long. The cost of constructing the tunnels was about $500 per yard. The total cost of constructing the tunnels, viaducts, stations, car sheds and track material was nearly five million dollars, while the electrical equipment and rolling stock cost nearly a million dollars.



THE STATION AT PRINZENSTRASSE.

THE BERLIN UNDERGROUND AND ELEVATED RAILWAY.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

LAST YEAR'S DEAD LETTERS.

THE annual report of the Dead Letter Office for the fiscal year ending June 30, 1902, shows that during the twelve months 9,300,351 pieces of mail matter of all kinds were received, an increase over the previous year of 793,094 pieces, or about 9.2 per cent.

The ordinary unclaimed letters were 6,440,600; ordinary unclaimed returned from foreign countries, 620,235; letters and parcels held for postage, 156,831; domestic letters undelivered at hotels, 306,232; letters and parcels with fictitious addresses, 150,307; bearing no address, 81,063, and matter originating in foreign countries, 838,805. The total number of pieces opened, including 243,557 parcels, was 8,216,407. The number of pieces delivered unopened, including 818,594 returned to foreign countries, was 1,083,231.

Of the letters and parcels opened 50,859 were found to contain money to the amount of $48,498, and 50,974 commercial papers of all kinds to the value of $1,399,926. There were also 2,254,734 articles of merchandise, books, etc., 71,340 photographs and 235,313 letters contained postage stamps. Nothing of value was found in 7,611,789.

The proceeds of the annual sale of merchandise matter realized $5,443, which, with money taken from letters which could not be restored to owners, aggregating $13,806, was turned into the Treasury.

THE UTILIZATION OF WASTES AND BY-PRODUCTS IN MANUFACTURES.*

WITH SPECIAL REFERENCE TO THE DECADE OF 1890-1900.

By HENRY G. KITTREDGE.

NOTHING in the arts of manufacture is more indicative of economic efficiencies than the utilization of products that have been rejected as wastes or residues in the industrial processes. The acme of industrial economy is the profitable employment of every atom of material in whatever form it may be presented or however obtained. Every particle of an organic or inorganic substance has a useful part to play in contributing to human necessities or pleasures, and when it performs no function toward some useful end, or remains dormant, it shows that the ingenuity and enterprise of man have not reached their fullest development or that the arts of the laboratory have not revealed all the secrets of nature. The refuse of today is a source of profit to-morrow; and this has been going on for years and probably will be going on for years to come, notwithstanding that even now there is little that is thrown aside as absolutely useless except as it may be utilized in the economies of nature. New revelations and new uses are constantly being found for substances of all kinds, whether in their original forms, or in their changed forms due to outside agencies. The world's increment of wealth is largely dependent upon finding new and more economical uses for materials, however exalted or humble they may be in the industrial scale, and especially the elevation of the humble to a higher plane of appreciated usefulness. If a thing is unused for man's enjoyment it is because it has not yet found its place of utility.

A nation's industrial greatness and wealth in the world's competition are definitely related to the skillful application of waste or residual materials in the arts and manufactures. The profits of industry are contingent upon the extent of the successful employment as materials of the by-products or wastes of industry. Success is oftentimes dependent on the superior utilization of that which is lowly in the scale of materials, so that it shall perform the functions of that which is more costly in a manner to satisfy the purpose for which the manufactured product is intended. There is nothing without an economic value for some purpose, if not in the industry in which it first appears, in some other where it can be turned to a profitable account. But while prevention of waste is of the highest importance in any process of manufacture, prevention of by-products is not always in the line of economy, rather it may be in the line of inexcusable waste. The valuable character of by-products is exemplified in the coal-tar products, from which exquisite colors and perfumes are obtained that minister to the caprices and pleasures of man, as well as to his needs. Matter that is the most unattractive, the most base, or the most offensive in its properties oftentimes contains the elements of the greatest usefulness and beauty.

Probably no science has done so much as chemistry in revealing the hidden possibilities of the wastes and by-products in manufacture. This science has been the most fruitful agent in the conversion of the refuse of manufacturing operations into products of industrial value. "Her magic wand has only to touch the most noisome substances and the most ethereal essences, the most heavenly hues, the most delicate flavors and odors instantly arise as if by magic." Chemistry is the intelligence department of industry.

For nearly a century the world's main supply of soap depended on soda, which was obtained as a product of the sulphuric-acid industry.† Notwithstanding soap was known to the ancients, it was regarded even in the middle ages as a luxury, and when it was not readily obtained, the lack of cleanliness was concealed by fine clothes and by perfumes. The soda industry being brought to a standstill in France during the French Revolution, the national convention of that country appealed to the chemists to discover some method for making soda from common salt, which had been shown by Du Hamel, in 1736, to contain the same base as soda. About forty years thereafter, Scheele found that caustic soda could be obtained from salt by the action of lead oxide; but the production of soda by chemical processes was unimportant from an industrial standpoint until Le Blanc secured results that gave to the world one of its principal industries. His discovery was based upon the treatment of chloride of sodium with sulphuric acid, forming hydrochloric acid and sulphate of soda. The hydrochloric acid was regarded as a by-product of so little value that it was allowed to pass off into the air, to the great detriment of vegetation in the neighborhood. To remedy this evil the English government took action against the soda works to compel them to condense the acid and keep it out of the way, and this led indirectly to the discovery that hydrochloric acid could be used as a valuable agent in the bleaching industry, which, however, was at that time far from having attained its present height of development. For use in this way it was found necessary to employ some agent to decompose hydrochloric

* Census Bulletin 190.

† Prof. H. B. Cornwall in Chautauquan, vol. 20, page 419.

acid, so that chlorine could be obtained from it, and the best agent was found to be the binoxide of manganese, which the acid dissolves, setting free a part of the original chlorine of the acid or of the salt and forming manganous chloride. Previous to about forty years ago this latter product was allowed to go to waste, and it was not until the demand for manganese oxide was so great and the price so high that a reclamation of the spent manganese was looked upon as desirable, that this was accomplished, adding greatly to the resources of the chlorine industry for bleaching.

The choicest perfumes that are placed upon the market are no doubt obtained from oils and ethers extracted from flowers; but there are many others which are artificially made, many out of bad-smelling elements. The fusel oil obtained in the distillation of spirits has an odor that is peculiarly disagreeable, yet it is used, after treatment with proper acids and oxidizing agents, in making the oil of apples and the oil of pears; and the oil of grapes, and the oil of cognac are little more than fusel oil diluted. Oil of pineapple is best made by the action of putrid cheese on sugar, or by distilling rancid butter with alcohol and sulphuric acid. One of the most popular perfumes has for one of its essential ingredients material which is obtained from the drainage of cow houses, though it may be obtained at a less cost from one of the products of gas tar, out of which is also obtained the oil of bitter almonds, so largely consumed in the manufacture of perfumed soap and confectionery.*

The refuse of cities throughout the civilized world is now generally collected and disposed of for sanitary reasons, though in many instances it is utilized to good advantage for industrial purposes. The collection of this refuse has been made only within a comparatively few years, but is now carried on systematically, being more or less self-supporting and advantageous from an industrial point of view. Formerly this refuse was simply accumulated and disposed of by burning, or casting into streams or onto waste land. Now bones, glass, rags, iron, paper, and other articles are separately collected and sold. Old tin cans are used (1) for the recovery of solder, (2) for the recovery of the tin, and (3) for remelting in the manufacture of steel or iron. The waste heat from furnaces, into which the inflammable refuse is thrown, may be utilized for steam purposes in operating engines for electric lighting and power. The city of Glasgow, Scotland, obtains waste heat from such furnaces equivalent to nearly 9,000 horse power per day of ten hours for power for manufacturing purposes.†

The food wastes of New York city are disposed of by what is known as the Arnold utilization process, which is, briefly, steam digestion and a separation of the cooked product into greases and fertilizer fillers. The greases are all, or nearly all, shipped abroad and, it is believed, refined and separated into several grades, such as "glycerin, red oil, lard oil, and inferior grades." It is not known that refineries in this country are as yet able to handle what is known as garbage grease, as the secret of the trade seems to be held abroad. The solids after being dried and screened are sold to the various manufacturers of "complete fertilizers," and by them made up into grades which seem to be particularly adapted for use in the cotton belt.

The process of utilization employed in New York is as follows: The garbage is delivered on the scows located along the water front and towed to a place of final disposition, which is at an average distance of about 25 miles from the dumps. It is there unloaded and placed immediately in steam-tight digesters and treated by steam under pressure varying from 30 to 80 pounds for about eight hours, the vapors of cooking being condensed and not permitted to reach the outer air. The cooked matter is then discharged from the digester into receiving tanks, and from the tanks goes to presses, where the grease, together with a greater part of the water, is separated from the solids. The remainder of the moisture is taken from the solids in either steam or hot-air driers. The grease and water are run into tanks or traps, and after gravity separation the grease is skimmed off, partially cleansed, and barreled for shipment. The solids taken from the driers are put through screens, where metals, bones, crockery, etc., are separated from the fertilizer filler proper. This filler is then cooled and bagged, and is then ready for shipment. The tailings from the screens go on the dumps. There is left then only the water which has been separated from the grease; this is evaporated to the consistency of a thick sirup, and as much of the sirup as can be so used is mixed with some of the solids before drying. This admixture with the evaporated "stick" produces a better grade of fertilizer filler than that which comes from the driers without treatment.

IRON AND STEEL INDUSTRY.

The economic uses of furnace slag have been greatly developed within the last few years. Formerly this slag was carted away from the furnace and disposed of in the most available place, as so much refuse material, hardly worth the cost of carting. It was considered an incumbrance of the smelting works, of no account except to fill up gullies and ravines, or to be thrown into the sea, if such a disposition could be made of it. Within very recent years it was estimated that the cost of removing this waste slag from the furnaces of England was no less than $2,500,000 annually. The amount of slag made by the iron furnaces of Great Britain is certainly immense. A considerable portion of this waste is now put to some profitable use as a substitute for artificial porphyry in the construction of buildings and for street pavements. Paving stones are made from it for the streets of Metz, Brussels, and Paris, of a quality sufficiently durable to stand heavy traffic. Mr. T. Egleston, in a paper read in 1872 before the American Institute of Mining Engineers, on the uses of blast-furnace slag, described a process by which, at a small cost, good bricks can be made of it, and a cement equal to the best Portland cement.

In an article contributed by F. Luermann to the Engineering and Mining Journal in 1898, it is stated that bricks manufactured from granulated blast-furnace slag are preferable, as building material for dwelling houses, to those made directly from fluid slag, since the former are porous, while the latter, being impermeable to air and steam, would cause the aqueous vapor exhaled by the occupants to condense on cold days, and thus render rooms damp and unhealthy. Good bricks may be procured from granulated slag mixed with dust from slag which has crumbled in the air, but the hardening process is rather slow. It is stated that slag brick is quite as strong as ordinary brick, while it may be heated, without injury to its strength, to a temperature at which carbonate of lime begins to decompose. Slag brick appears to be particularly adapted to the construction of chimneys, for lining limekilns, and for boiler setting. The manufacture of slag brick is carried on in Russia, and it is stated that the brick made there possesses strong hydraulic properties capable of withstanding high and low temperatures, weighs less than stone, and requires less mortar when laid. Its tensile strength is about 312 pounds; its crushing strength, 1,250 to 5,600 pounds per square inch, according to the time of hardening.*

At the Karl-Emil Hutte, in Koniginhof (Bohemia), bricks are said to be made from the cinder produced in a coke furnace smelting an oolitic impure clay ironstone. The slag is run from the cinder notch into water, where it is granulated to a gray-colored sand. It is then mixed in a mill with milk of lime and pressed into bricks, which must be left for eight days to harden before they will bear transporting. The bricks are made to stand a pressure of 256 pounds per square inch, though they are guaranteed only to carry two-thirds of this amount. The whole width of the brick should withstand a load of 5 tons.†

In a paper read very recently by Edwin C. Eckel, before the American Society of Civil Engineers, on slag-cement manufacture in Alabama, it was said:

"American technical literature contains little upon the subject of slag cements. This is the more curious as the matter would seem to be of considerable importance to engineers. For whatever the value of slag cement may be as a structural material, the industry has become fairly well established in this country, at least six factories being at present in operation, and I believe that all the plants are in a comparatively prosperous condition. The materials used in the manufacture of slag cement are blast-furnace slag and slaked lime. Two slag-cement plants are now in operation in Alabama, both being located in the vicinity of Birmingham, in close proximity to large supplies of both lime and slag of proper composition."

Slag-cement works have been established in a number of European countries, but probably the greatest development has been reached in Germany. It was stated in a communication to the Architectural Association of Berlin, in 1892, that there were then in that country ten slag-cement factories, with an annual production of 600 tons. About this time the Maryland Steel Company intrusted R. W. Mahon with an investigation of the slag from their blast furnaces to determine its value for cement making, and laboratory experiments were made which became the subject of a paper that was read before the chemical section of the Franklin Institute, in 1893. The result of these experiments was to answer the question affirmatively whether it was possible to make from slag a cement. The slag used was the refuse of Mediterranean ores and an ore mined in the island of Cuba. The limestone came from a point near the city of Baltimore.

It has been found that an admixture of prepared slag with cement adds to its tensile strength in the end, but is apt to have the effect of slightly lowering the initial strength of the cement; i. e., the resistance to tension and compression which the cement acquires within, say, from one to seven days. This defect, however, says A. D. Elbers in the Engineering and Mining Journal of 1897, can be overcome by treating the prepared slag with an aqueous solution of sodium carbonate, rendering it so efficient that a suitable admixture of it with Portland cement is apt to raise the tensile strength of the latter from 50 to 100 pounds per square inch.

Thomas or basic slag is now used by fertilizer manufacturers in large quantities instead of imported phosphate rock, especially in Germany, where the total consumption of basic slag in 1896 was estimated at 800,000 tons. During the same year there were 83,765 tons of this slag imported into Germany, while the exports, chiefly to Belgium, were 134,257 tons.*

Reference is made in the Journal of the Society of Chemical Industry, 1897, to the recovery of tin from spent tin baths by the treatment of the oxide of tin with hydrochloric acid in the presence of metallic tin. The process is also utilized for the recovery of tin from the waste liquors of the dyehouse containing tin in solution. From such waste solutions the tin is precipitated by means of lime, sodium carbonate, sulphuric acid, sodium sulphate, etc. The oxides are digested in concentrated hydrochloric acid. As long ago as 1861, Messrs. Edward and Charles Kuhn, chemists of Sechsbaus, near Vienna, took out a patent for producing pure tin, good weldable iron, ammoniac, prussian blue, and some minor products from the waste clippings of white iron.† A firm at Manchester, England, utilizes the tin from waste tinned iron (scrap tin) in the manufacture of stannate of sodium.

A very important innovation in the metallurgical industry in Germany is the utilizing of the waste gases of blast-furnaces for working gas engines. That the waste gases can now be made serviceable in their entire heating capacity by a rational burning in gas engines, is one of the most important steps that have been recently made in science in its adaptations to practical technics. What this improvement means, economically, is seen by a theoretic calculation according to which this use yields a profit of $1.25 per ton of pig-iron production, which means for Germany alone, where the utilization of these waste gases is made, a gain of over $10,000,000 on her entire wrought-iron production.

Gas machines for utilizing these gases were introduced into Germany about 1898. Good results were reported from all quarters, which led to the belief that this is a material advance in the development of an important gas-machine industry. So confident are those who are interested in it, that blast furnace gas engines of large dimensions have already been erected at different places in that country. An establishment at Donnersmarck may be particularly mentioned as having erected a gas dynamo of 600 horse power. The managers calculated that if the quantity of gases which hitherto, when burning under boilers, produced 1,000 horse power in round figures, be used for burning in gas-power machines, the production would be increased to about 2,700 horse power.

To utilize these gas engines to their greatest advantage it has been thought that electricity would have to be employed. The electric transmission of power acts as an auxiliary, which is regarded as an incalculable advantage, notwithstanding the loss of about 20 per cent in energy. The Cockerill Company, of Serainty, Belgium, with the co-operation of Mr. E. Delamare-Debouteville, is said to be first to solve successfully the problem of the direct utilization of blast-furnace gases as a source of energy. Since 1895 a gas engine of this kind has been in operation at the works of this company, and their 600 horse power single-cylinder gas engine exhibited at the Paris Exposition of 1900 attracted a great deal of attention

THE STATION AT THE STRALAUER THOR.

THE BERLIN UNDERGROUND AND ELEVATED RAILWAY.

* Lord Playfair in North American Review, vol. 153, p. 505.
† Journal of State Medicine, vol. 5, p. 501.

* Journal Society of Chemical Industry, vol. 17, p. 1049.
† Journal Society of Chemical Industry, vol. 16, p. 144.

* Engineering and Mining Journal, May 8, 1897.
† Waste Products and Undeveloped Substances, P. L. Simmonds.

from those interested in the metallurgical industry."

In 1899-1900 there were imported and entered for consumption into the United States, for remanufacture only, 26,307.46 tons foreign waste and refuse, scrap iron and steel.

LUMBER AND TIMBER PRODUCTS.

Nearly all of the formerly waste products of lumber and timber are now turned to some utility, and some of the new products thus formed are of considerable value. Of this latter class may be mentioned sawdust, which was formerly considered an absolutely waste material, and was allowed to float down the stream or was thrown into a heap where it could be most conveniently disposed of. French cabinetmakers have found a way of preparing this material which gives it a value far above that of solid timber by a process that has been in vogue for at least twenty-five or thirty years, combining the use of the hydraulic press and the application of intense heat. By this process the particles of sawdust are formed into a solid mass capable of being molded into any shape and of receiving a brilliant polish, and possessing a durability and a beauty of appearance not found in ebony, rosewood, or mahogany. This product is known as "Bois durci." Artificial woodwork, therefore, seems to have a promising future. Alum, glue, and sawdust, kneaded with boiling water into a dough, and pressed into molds when dried, is hard and takes on a fine polish. Ornaments of great beauty can be made from it very closely resembling carved woodwork.†

The production of acetic acid, wood naphtha, and tar from sawdust is one of the latest enterprises in Norway. A factory has been started at Fredrikstad capable of distilling 10,000 tons of sawdust in a year. It also manufactures charcoal briquettes, which are exported to the Netherlands. The acids are chiefly placed on the German market, while the tar is mostly consumed at home. The factory is said to be the first of its kind erected in that country.‡ According to an English patent of 1897, sawdust may be so prepared as to be noninflammable, and then applied to jacketing of boilers and other purposes.

In the Journal of the Society of Chemical Industry, for 1898, is described a series of experiments for obtaining alcohol from either coarse or fine sawdust, without affecting the yield. It was found that pine sawdust as compared with fir sawdust was superior as yielding a purer alcohol. It was also found that a high yield of sugar was obtained from birch sawdust, the yield of sugar being about 30.8 per cent of the quantity of birch wood used. The quantity of alcohol obtained from 220 pounds of air-dried sawdust (20 per cent water) was 7 to 8 quarts. The quality of the alcohol distilled from the fermented liquid was said to have been excellent, and the preliminary experiments indicated that the trifling impurities found in it could be readily removed.§

A patent taken out in England in 1896 for utilizing certain waste products of wood describes a process of constructing or manufacturing a product resembling wood from a mixture of sawdust or wood refuse and certain quantities of gums, resins, or other suitable agglutinants, either in a dry state or dissolved, the compound being subjected to pressure at a temperature sufficiently high to soften or melt the gums or resins.

According to the United States census of 1900 the amount of sawdust used in the clay and pottery industry of this country cost $19,687, or 0.17 per cent of the total cost of all the raw materials used.

The utilization of wood pulp in the manufacture of paper is not new, but its increased use is very marked, as will be seen by comparing the statistics of the census of 1890 with those of 1900, in the amount of raw materials used in the manufacture of paper. Early in 1826 the brothers Cappucino, paper makers of Turin, discovered a means of supplying the need for paper-making material, caused by the scarcity of rags in the fabrication of paper, by substituting the thin bark of the poplar, willow, and other kinds of wood. The good quality of the paper made from this material was recognized by the Academy of Sciences, after an examination of the manufactured product, and so important was the discovery considered that the King granted the brothers an exclusive privilege for ten years for the manufacture of paper from ligneous materials.‖ In 1833 a patent was granted in England to J. V. Deagrand for making paper and pasteboard from wood reduced to a state of paste. Poplar wood was thought at that time the best for this purpose, as it had been in Italy twelve years previous. A patent was granted in 1855 to William Johnson for improvements in the application of various substances containing wood fiber, as the bast, or inner bark, of the lime tree, the willow, birch, and alder, to the manufacture of wood paper pulp. At the London International Exposition of 1862 Wurtemburg contributed several samples of paper made from wood pulp mixed with rags, the proportion of the former varying from 10 to 80 per cent; and the paper was reported to be serviceable although of a low grade. The wood was simply rubbed down into pulp against the periphery of a wheel prepared with a rough face. At the Paris Exposition, 1867, was to be seen in action a large machine of 50 horse power for making wood pulp for paper. Only white woods were thought to be available for this purpose.

There is no limit to the range of wood suitable for paper making, though the pine family is most suitable for this purpose, and invention has been mainly directed to methods for reducing wood to a suitable condition for use in paper manufacture. The first method of preparing pulp from wood was to reduce the wood to thin shavings, which were soaked in water for a week or more, then dried, and then ground to powder by a crushing mill of some kind. This powder was mixed with rags to form a pulp, in which condition it was suitable for converting into paper. The principal defect in this method was the production of a very short fiber. Chemically produced pulp was resorted to as better preserving the natural fiber of the wood. The chief objection against it was its cost, but this has now been largely, if not entirely, overcome and the industry placed upon an economical basis.

The value of pulp wood entered for consumption in the United States for 1899-1900 was $1,109,139.11; the wood pulp entered for consumption in 1899-1900 was as follows:

	Pounds.	Value.
Mechanically ground	70,222,823	$491,889.36
Chemically bleached	20,112,995	476,456.00
Chemically unbleached	90,207,760	1,436,052.36
Total	180,543,578	$2,404,397.72

The utilization of the needle-shaped leaflet of the pine tree, either alone or in combination with some other fiber, as cotton, for example, has frequently been attempted with more or less success to produce an article of commercial value for textile or other purposes. Near Breslau, in Silesia, there have been erected factories that convert the pine leaves into what is called "forest wool," for wadding. Other factories have been erected in other parts of Europe for a similar use of these leaflets, as in Sweden, Holland, and France. The products made from these pine-tree leaflets have been exhibited at a number of expositions, where they attracted more or less attention as furnishing suitable material for stuffing mattresses and articles of furniture in place of horse hair, for manufacture into hygienic fabrics for medical use, and for articles of dress, such as inner vests, drawers, shirts, chest preservers, etc. In the preparation of the textile material an ethereal oil is produced, which is employed as a curative agent and oftentimes as a useful solvent. Some attempt has been made of late in the State of Oregon to make use of these leaflets by reducing them to a fibrous condition suitable for mixing with cotton, to be spun into yarn for weaving.

(To be continued.)

* Journal of the Society of Arts, vol. 48, p. 860.
† Waste Products and Undeveloped Substances, P. L. Simmonds, p. 217.
‡ Journal Society of Chemical Industry, vol. 17, p. 81.
§ Journal Society of Chemical Industry, vol. 17, p. 1154.
‖ Waste Products and Undeveloped Substances, P. L. Simmonds.

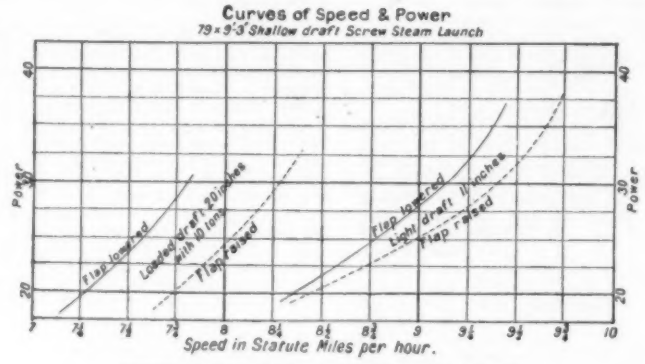
SHALLOW-DRAUGHT STEAMER.

AMONG those who have devoted a considerable amount of time and attention to the question of the navigation of shallow rivers are Messrs. Yarrow & Co. This firm, as many of our readers will be aware, has built a large number of shallow-draught boats for the rivers of South and North America, West Africa, the Nile, China, etc. It has just recently introduced a new feature into screw-propelled boats of this type, by reason of which a great economy is claimed. We were invited to witness on Tuesday last a trial run made with a small boat constructed so as to embody the new invention. It will be of interest perhaps if we just recall the three types of steamers suitable for use on shallow waters. First there is the side paddle vessel, the use of which is impossible in restricted channels or where much floating timber is encountered. Then there is the stern-wheel steamer, which is not open to these objections. Both these types, however, suffer from the fact that they lose in efficiency as the depth of draught increases. Moreover, the machinery needful to drive them is heavy, which limits the carrying capacity of a given sized boat with a given draught. The third type of boat is screw driven. Many vessels of this class have been constructed with the propeller working in a sort of tunnel, so that though the propeller used be greater in diameter than the draught, yet it always works in solid water, since the water, owing to the air being driven out of the tunnel by the action of the screw, rises and completely covers the latter. Until quite recently the stern portion of this tunnel has been fixed so that when the boat is heavily loaded there is a considerable portion of the back of the tunnel against which the water delivered from the propeller must impinge, and down which it must slide before it can escape. This has caused a "drag," and a consequent loss of speed and efficiency. See Fig. 3.

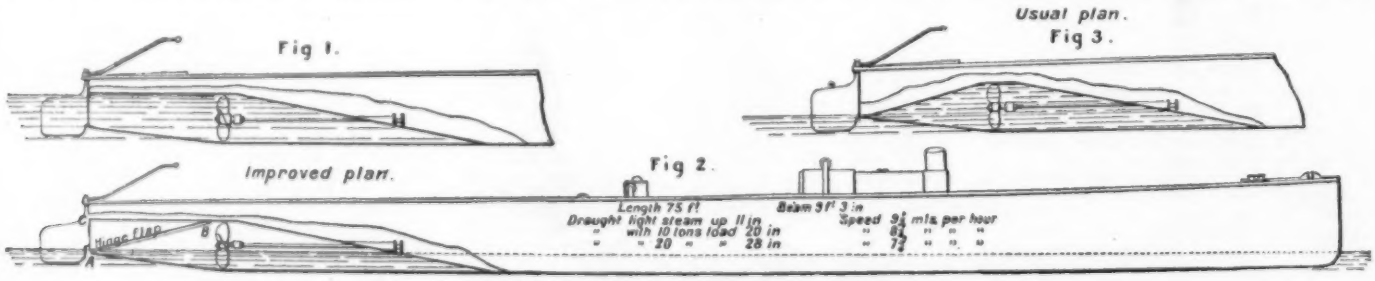
In the new invention, instead of being fixed, the rear portion of the tunnel is formed of a hinged flap provided with strips of rubber at the side, which, by rubbing against the parallel sides of the tunnel, prevent the ingress of air. With a boat so provided, the rear end of the tunnel can be always so arranged that it only just dips beneath the surface of the water. This is quite sufficient to insure the screw always working in water, but under all circumstances opposes a minimum obstruction to the escape of the water.

It must be remembered that the weight of machinery needed when paddles are used is greatly in excess of that required for a screw-driven boat. Hence it is always an advantage from all points of view to use a screw propeller, and this advantage is enhanced by the present invention, by which the efficiency remains practically the same, no matter what the depth of draught. A glance at the accompanying sketch will serve to make the foregoing clear, and to explain exactly the working of the stern flap. See Figs. 1 and 2.

We had an opportunity of watching in action a small shallow-draught boat constructed on this principle, and we also had a ride of some distance on her. She appeared to work wonderfully well. Her length was 75 feet, and beam 9 feet 3 inches. Her draught light, but with steam up was 11 inches, and this was the condition in which we saw her. Her speed at this draught was, we were informed, 9½ miles an hour. We should have estimated it at higher than this. With a 10-ton load her draught, so we were informed, was 20 inches, and her speed with the same power 8¼ miles an hour, while with 20 tons she has a draught of 28 inches and a speed of 7¾ miles an hour. The accompanying diagram shows some comparative efficiency curves obtained by the makers. It is claimed that, taking an example of a 10-ton load, there is a gain of half a knot with the same power with the flap only just immersed, as compared with the flap lowered to such a point as would represent the fixed back of an ordinary tunnel. Assuming the power required to be as the cube of the speed—which is approximately correct—this shows a gain of 25 per cent. To have obtained the result shows a great advance over older methods. The draught, as we have said, was only some 11 inches, but the diameter of the propeller used was 2 feet 6 inches. The propelling machinery consisted of a single-cylinder vertical engine supplied with steam from a small locomotive type boiler, the two being placed close together, thus avoiding the waste in long steam pipes so noticeable in stern wheelers, where the boilers have to be placed right forward.—The Engineer.



COMPARATIVE EFFICIENCY CURVES OF LAUNCH



YARROW SHALLOW-DRAUGHT LAUNCH.

THE SMOKELESS COMBUSTION OF BITUMINOUS FUEL.*

THE author points out that engineers are taught the conditions necessary to combustion, but they do

* Abstract of paper read by W. H. Booth, M.Am.Soc.C.E., before Section G, British Association, Belfast.

not practise them, and the modern boiler is fixed in the most primitive manner.

Certain fuels burn without smoke, and may be burned directly below the heat-absorbing surface. This cannot be done smokelessly with hydrocarbons, because of the greater avidity of hydrogen than of carbon for oxygen, and the necessity of preserving a high temperature for burning hydrocarbon gas. The difference between long and short flaming coal is pointed out and the effects noted.

The effect of refractory furnaces is discussed in the paper. The refrigerating effect of volatilizing solid hydrocarbons is discussed in its effect on the distribution of temperature in a furnace, and the production of heat at and beyond the grate surface. Though less heat is produced at the grate surface, the total heat-production of bituminous coal is eventually secured if suitable furnace arrangements are provided for the purpose.

The faults of everyday boiler settings are pointed out in respect to various types of boilers, and the bad effect of cold-water pipes in the path of the furnace gases is referred to. Though so bad as a smoke producer, the common form of water-tube boiler can easily be set so as not to produce smoke. The furnaces must be so arranged that all the gaseous products of the furnace are swept together with all the admitted air, and are not cooled down until sufficiently burned to admit of being used. For this purpose furnace linings must be non-heat absorbent. Small-tube boilers are condemned in their more common forms, and the arrangement of the refractory furnace of the Weir boiler pointed out as affording economical and smokeless combustion.

The locomotive is also instanced as an example of how partial recognition of the correct principles has been fairly successful.

Some of the attempts to secure smokeless combustion are discussed, and the conviction expressed that there is nothing in smoke prevention to justify the assertion so often made that it is economically impossible. The final conclusion is that smokeless combustion of bituminous coal is as easy and certain as the reverse method.

THE WORLD'S COAL PRODUCTION AND CONSUMPTION.

THE coal production and consumption of the world, and especially of the United States in comparison with other coal-producing countries, is the subject of a monograph which will appear in the forthcoming issue of the Monthly Summary of Commerce and Finance, issued by the Treasury Bureau of Statistics.

The general demand for coal seems to have increased very rapidly in recent years, not alone in the United States but throughout the world. One of the most characteristic features in modern industrial development has been the rise of the coal industry. Modern society relies upon coal as the fuel and source of power, and the terms "iron age," "machine age," and "age of steam" may all be translated the "age of coal."

The rapidity with which the production of coal has increased may be appreciated when the present volume of that production is considered and when we reflect in how recent a time the production formed but a very small fraction of that quantity. In 1901 the total coal production of the world was 866,165,000 short tons. Until as late a period as 1883 the world's production had never been half so great being only 450,990,000 metric tons in that year; and not until 1872 had the world's production been as much as a third as large as it is at present. By 1864 the world's production was only 174,000,000 metric tons, or less than 23 per cent of the production of 1901. The statistics of the world's production for still earlier periods cannot be determined with any pretense of accuracy; but on the basis of the British statistics from 1854, and of estimates for earlier periods, and from such statistics as are obtainable from France, Germany, Belgium and Austria-Hungary, an approximation may be made of the actual production. In 1860 the world's production of coal was about 144,000,000 metric tons, or less than one-fourth of the production of 1901, and considerably less than the production of either the United States or the United Kingdom at present. Ten years earlier the world's production amounted to only about 83,000,000 metric tons, about one-tenth of the present world's production and considerably less than the present output of the single State of Pennsylvania. In 1840 the production was much smaller still, amounting to little over 45,000,000 metric tons, or about one-seventeenth of the present output; while during the three-quarters of a century since 1820, when the output was about 17,000,000 tons, the production has increased about 4.5 per cent.

While the figures for the world's production prior to 1864 are necessarily defective, owing to the absence of accurate statistics for the English and American industry, they sufficiently indicate the immense development of the industry during the last century. The significance of this development cannot be overlooked.

The production of coal is chiefly in the hands of three nations, the British, the American and the German. During the last thirty years and even earlier, the combined coal output of the United States, the United Kingdom and Germany has averaged, year for year, about five-sixths of the coal output of the world. Possessing but a tenth of the world's population, they have produced about 83 per cent of the mineral fuel, while the remaining 90 per cent of the world's inhabitants have produced only about 17 per cent of the coal, and even if the savage and semi-barbarous nations be disregarded, the immense preponderance of coal production in these countries must be conceded. To this group might be added Belgium, which produces and consumes more coal per capita than any other European country except the United Kingdom, but for the fact that its small population places it in the second rank of coal-producing countries.

While the continued output of these three countries has kept pace with the production of the rest of the world, their relative position has been materially altered. In 1868 the United Kingdom produced over three times as much as either the United States or Germany, the output of these countries being approximately 52, 14½ and 16½ per cent of the world's production, respectively. In 1870 the proportion was about the same, although the United States had gained upon Germany as a coal producer. By 1875 the output of the United Kingdom was still considerably greater than the combined production of the United States and Germany, the output of these three countries being 45, 20 and 18 per cent of the world's production, respectively. The next half decennial period witnessed a remarkable increase in the American production and a corresponding relative decrease in that of Great Britain, the proportion of those countries being 36, 28 and 17 per cent, respectively. This increase was maintained during the latter part of the past century, and in 1896 the output of Great Britain and Ireland was only 34 per cent, that of the United States already 30 per cent, and that of Germany 19.2 per cent of the coal production of the world.

In 1899, for the first time, the coal production of the United States exceeded in quantity that of Great Britain. This superiority has been maintained for two successive years. During 1901 the United States production was greater than the amount of coal produced in Great Britain and all her colonies. During that year the shares of the leading coal-producing countries were as follows: United States, 34 per cent; United Kingdom, 28 per cent, and Germany, 19.2 per cent. Nor is there any prospect that the leading position of the United States may be lost in favor of another country within any calculable future time.

OIL AND GREASE SEPARATOR.

WE illustrate an oil and grease separator for the exhaust of condensing engines, which is in many respects novel in design and for which there is claimed very exceptional efficiency, on account of the care with which the details have been worked out to prevent the grease, when once precipitated, from being again picked up by the steam and carried forward, or from creeping along the insides of the castings, as it is apt to do. Fig. 1 shows the complete apparatus, the steam entering at the left and leaving at the right. Fig. 2 is a vertical section and Fig. 3 a horizontal section of the separator itself. It will be noticed that at every point where it is likely that oil will strike or will creep along the surface, provision is made for trapping it. Thus, where the steam pipe joins the separator, and the area is constricted (Fig. 3), there is a flange *A* to prevent the oil which creeps along the sides of the pipe from entering the interior of the separator. This flange diverts the oil into a trap, which is connected by a pipe *B* to a tank (Fig. 2). Similarly, at the exit of the separator there is a second flange *C* (Figs. 2 and 3) for a similar purpose. Facing the inlet (Fig. 3) there is a diverging baffle-plate *D* with forwardly-projecting ribs, and provided with an enclosed chamber behind, through which cold water is circulated by the pipes *E* and *F*, the effect being to keep the baffles cool and moist, and assuring the adhesion of oily particles. The exhaust steam entering the separator is diverted to the right and left by the baffle-plate. The momentum of the liquid particles brings them in contact with the baffle, where they are diverted inwardly and immediately taken out of the course of the steam. It is scarcely possible for any separated impurities to be again picked up by the steam and carried through the separator. It will be noticed that there is exceptionally small diversion of the course of the steam, minimizing any risk of back pressure.

Fig. 1 illustrates the separator connected up to an automatic alarm discharge tank. This tank is connected to a live-steam pipe *G*, and when full the ball rises, causing a steam whistle to sound; the tank is then discharged by the engineer by means of live steam. Its advantages are that the alarm is automatically sounded when attention is necessary, and, further, when communication with the exhaust pipe is re-opened, steam, and not air, is admitted.—Engineering.

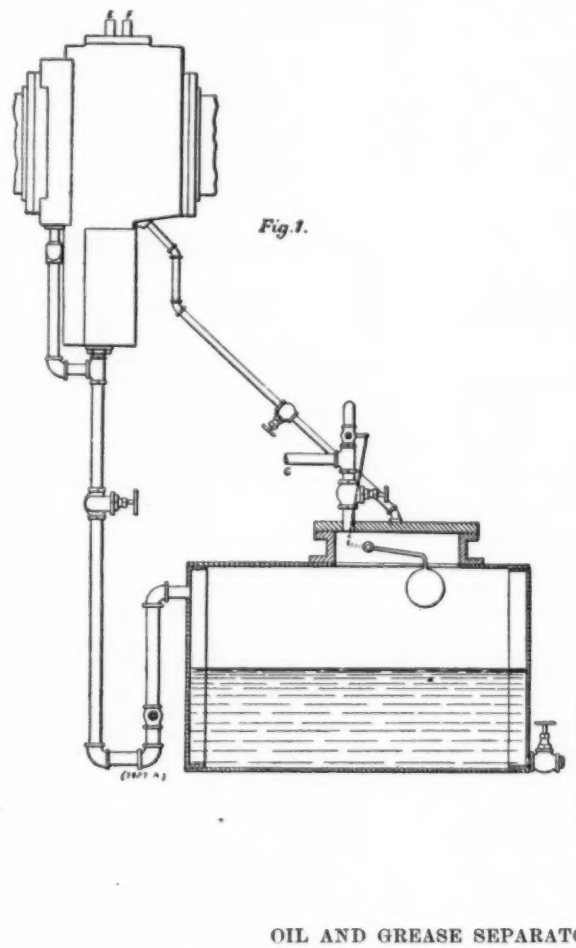


Fig. 1.

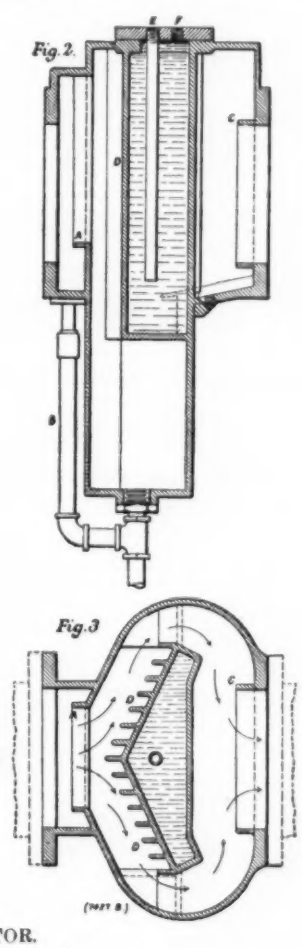


Fig. 2.

Fig. 3

OIL AND GREASE SEPARATOR.

TEMPERATURES AT GREAT ALTITUDES.

AT the recent International Aeronautical Congress at Berlin M. Teisserenc de Bort, of Paris, presented the results of his observations on the decrease of temperature in the high atmosphere, as obtained from the ascensions of 258 *ballons-sondes*, which had reached or exceeded 11,000 meters, the total number of ascensions being 540, all of which were made at night to avoid the effect of insolation. The concordant and remarkable result is that in the layer between 8,000 and 9,000 meters the decrease of temperature becomes slower, ceasing entirely at 11,000 meters, while above that height a warming may set in, with fluctuations of 1 degree to 3 degrees centigrade, making the temperature here on the average nearly constant. In the summer this isothermal layer appears to lie somewhat higher, or between 13,000 and 14,000 meters. It is lower during the prevalence of a depression, but 4,000 meters higher during a high pressure, so that the zone exceeds the height of the cirrus clouds. The lowest temperatures, occurring in a high pressure, were —67 degrees and —72 degrees, but in March the exceptionally low temperature of —75 degrees centigrade was observed. Whether the absolute minimum of temperature has been reached here requires further proof and as to the cause of this striking phenomenon there are only conjectures. Have we at these great heights aerial conditions working on a grand scale, where the cyclonic whirls of the lower atmosphere do not penetrate and the currents flow uninterruptedly, and must we assume, with Maxwell, that there are stages in molecular movement where gravity and its attendant phenomena no longer act?

Prof. Dr. Assmann said that in a memoir on this subject which he had presented to the Berlin Academy of Sciences he showed that the observations of the Berlin Aeronautical Observatory, although obtained by a somewhat different method, led to the same conclusion as that which had been reached at Trappes. Above 10,000 meters the temperature oscillates and does not appear to decrease, although beyond the variable stratum, at 17,000 meters, and recently as high as 19,500 meters, the temperature was again found to decrease, so that the possibility of an absolute minimum of temperature is by no means excluded. The Berlin observations were executed with specially constructed balloons of Para rubber, which entirely avoided in the daytime the influence of solar radiation on the instrument, which was also inclosed in double polished tubes. During the six high ascensions, of which the observations have been reduced, the results stated by Teisserenc de Bort were confirmed and rises of temperature amounting to 9 degrees, with the decreases of temperature already mentioned at still greater heights, were found. During the high ascension of Berson and Süring on July 31, 1901, the tem-

perature of —40 degrees was read at the identical height where the thermograph of a registration balloon, sent up at the same time, recorded —38.4 degrees. Berson thinks it probable that the increased warmth of the anticyclone ceases between 6,000 and 8,000 meters and at great heights the air in the anticyclone becomes colder than that in the cyclone.—Monthly Weather Review.

RADIO-ACTIVITY AND THE ELECTRON THEORY.*

ELECTRONS emanating from radio-active bodies behave like material particles, and are impeded by the molecules of the surrounding medium, in contrast with ether waves, which are not thus affected except by absorption. It is not difficult to put these indications to test. A pair of shallow cells, *A B* (Fig. 1), 1.5 millimeters deep and 25 millimeters square, were made by cementing slips of glass to a thick glass plate. The cells were filled to the same depth with a radio-active substance chiefly containing actinium.† Over cell *A* was placed a piece of thick lead pipe 28 millimeters high and 25 millimeters internal diameter, to ensure that any emanations from the active substance in *A* would be confined to the inside of the hollow cylinder. The radio-active substance in *B* was freely exposed to the air, save for a pillar of lead at *C*, to support the sensitive film. A sensitive film was laid horizontally over the cylinder and support, *C*. On the film was a plate of glass, and cylinder and film were pressed together by heavy weights. The whole was covered in a light-tight box and put in a dark cupboard.

At the end of forty-eight hours the film was removed and developed. There was a strong action shown over cell *A* (the one covered by the lead cylinder), but over *B*, the cell exposed to the air, there was no visible impression. Measured in Mr. Chapman Jones' "Opacity Meter"‡ the results were:

Image over cylinder—Opacity log.§ = 0.79; Opacity‖ = 6.17.

The experiment was repeated, using the same apparatus, but a different preparation of actinium. In this case the exposure was for seventy-two hours. As before, there was a strong impression over cell *A* and none over cell *B*. The figures were:

Opacity log. = 0.89; Opacity = 7.71.

These experiments indicate that the electrons from the radio-active agent, chiefly actinium, partake of the properties of a fog or mist of material particles, capable of diffusing away in the free air like odoriferous particles, when not kept in by a thick metal screen.

A further experiment was now tried with the same

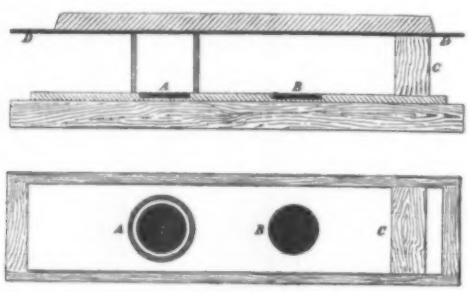


FIG. 1.—ELEVATION AND PLAN.

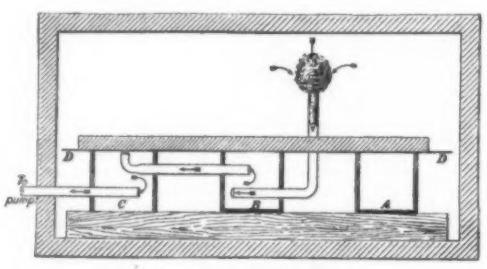


FIG. 2.—ELEVATION.

apparatus, the agent a strongly active radium and barium bromide. This material being self-luminous, a sheet of black paper was placed immediately over it, so that nothing but emanations capable of passing through the opaque paper would be subject to experiment. After four hours' exposure in total darkness, the film was developed. A good circular patch was obtained over cell *A*, and a faint diffused darkening showed over the rest of the film, darker at the spot immediately over cell *B*, fading away at the sides as the distance became greater. That this action was due to the material in the open cell, *B*, and not to the general fog over the plate, was seen by the clearness of the film where covered by the lead, and where shadows were thrown by the lead cylinder and pillar.

Circles of the same diameter were drawn round the dark impression over *A*, and round the darkest part of the impression over cell *B*. Measurements were taken of different parts of the spaces inclosed in these circles, and the mean of all these came out:

Circle over cell *A*—Opacity log. = 0.53; Opacity = 3.39.

Circle over cell *B*—Opacity log. = 0.32; Opacity = 2.09.

Ratio *B*/*A* = 0.62.

The experiment was repeated, with the addition of a sheet of aluminium, 0.2 millimeter thick, under the black paper, the electrons now having to pass through both paper and metal before reaching the film.

The exposure was for six hours, and the appearance on development was very similar to the last: a dark disk over the protected cell, *A*, and a diffused action over the other part of the film, except in the shadow of the lead supports. Measurements as on the previous occasion gave the following results:

Circle over cell *A*—Opacity log. = 0.78; Opacity = 6.03

Circle over cell *B*—Opacity log. = 0.48; Opacity = 3.02.

Ratio *B*/*A* = 0.5.

Finally, I tried polonium subnitrate, which gives off emanations hardly capable of passing through any screen, and greatly obstructed by a few centimeters of air.

The apparatus was substantially the same as the one just described, with the modification that the lead cylinder was 12 millimeters high, and at the other end a rod of glass 12 millimeters high was used to support the film. The reduced height was chosen, experience showing that polonium emanations have great difficulty in penetrating many millimeters through air. The exposure was seven days, at the end of which time the film was developed. Over cell *A* a dark disk sharply defined the inside of the cylinder, while over cell *B* was a hazy, diffused patch which to the eye looked much the fainter of the two. But measurements of patch *A*, and of a disk over cell *B* of the same size as *A*, showed that the opacities in each case were practically identical, as shown by the following figures:

Circle over cell *A*—Opacity log. = 0.74; Opacity = 5.49.

Circle over cell *B*—Opacity log. = 0.76; Opacity = 5.75.

Ratio *B*/*A* = 1.05.

A repetition of the experiment, taking the mean of five concordant results, gave the same opacities as before.

Without proving that the emanations from polonium are less material than those from actinium and radium, this experiment shows that their behavior is entirely different as regards diffusibility through air. Whether this is due to the larger mass of the individual particles, or to the less distance they have to travel (12 millimeters, as against 28 millimeters in the case of actinium and radium), or to some other cause, further experiments must decide.

Dr. Rutherford shows that air which has remained for some time in the neighborhood of thoria and then is carried in a current to a distance retains its property of communicating radio-activity to other bodies. He explains these phenomena by supposing that thoria gives off a special kind of emanation capable of being conveyed by the air, and that this is the cause of the induced radio-activity.

To ascertain if the electrons or corpuscles from radium also possess the property of being carried along in a current of air I fitted up an apparatus shown in Fig. 2. *A*, *B*, and *C* are three brass tubes closed at the lower end and cemented with paraffin to a wooden block. The upper ends were accurately ground to a level surface and then coated with a thin layer of paraffin wax. Holes were drilled in *B* and *C*, to admit glass tubes, cemented air-tight into the cylinders, as shown in the figure. The upper end of the tube in *B* was closed with a plug of cotton wool, and the outer end in *C* was connected to a water pump, so that when the cylinders were closed at the top a current of air was drawn through *B* and *C*. As the radium compound was self-luminous, disks of thin aluminium foil were placed over cylinders *A* and *B* to cut off the luminous rays. A sensitive film was laid on the three cylinders over the aluminium, and it was tightly pressed down by a heavy weight, the contact between the film and the tops of the cylinders being sufficient to make the whole air-tight. At the bottom of *A* and *B* a radium compound was placed, equal weights and equal surface in each. The whole was put into a light-tight box, and air drawn through. The cylinder, *A*, was used only as a standard. The air passing into *B* was expected to carry along with it some of the corpuscles emitted from the active material at the bottom; and the inlet tube in *C* was turned up at the end, so that the stream of corpuscle-laden air should impinge on the surface of the center of the film on *C*, and if it carried with it any radio-active properties the result should be seen on development, by the production of a dark patch. If, however, the air carried no corpuscles, there would be no image on the sensitive film over *C*.

The experiment was continued for eleven hours, 120 liters of air having passed through in the time.

On development and measuring the resulting images the following figures were obtained:

Circle over cell *A*—Opacity log. = 0.342; Opacity = 2.20.

Circle over cell *B*—Opacity log. = 0.178; Opacity = 1.51.

Circle over cell *C*—Opacity log. = 0.025; Opacity = .11.

Ratio *B*/*A* = 0.68.

It thus appears that a current of air passed over the surface of a radium compound carries with it a certain proportion of the corpuscles. This is proved by the diminished photographic action in the second cell, slightly confirmed by the evidence that some few of the corpuscles so carried away get to the sensitive film on cell *C*. Judging from our slender knowledge of the properties of free electrons; it is highly probable that they will not easily turn a corner, but cling to the sides of the tube through which they are being led. On the other hand, the constant collisions with the atoms of air may reduce their initial mobility almost to a vanishing point before they have traveled along the tube between *B* and *C*, and then they would be carried along with the air.

The experiment was repeated, using a preparation of actinium (Uranium X). It was kept going, for seventy-two hours, during which time 750 liters of air were drawn through the apparatus. On development and measurement, the following results were obtained:

Circle over cell *A*—Opacity log. = 0.99; Opacity = 9.78.

Circle over cell *B*—Opacity log. = 0.67; Opacity = 4.68.

Circle over cell *C*—Opacity log. = 0.25; Opacity = 1.78.

Here then the results agree with those tried with radium compounds; that corpuscles are carried by a current of air from cell *B*, through the connecting tube to cell *C*. They also confirm those of Dr. Rutherford—who finds that thorium emanations travel in a current of air while retaining their activity—and of P. Curie and A. Debierne, who show that induced radio-activity can be transmitted through capillary tubes, of an internal diameter of .1 millimeter and 75 centimeters in length, bent once at right angles.

I have not obtained, however, a similar result with the emanations from hydrogen peroxide. As shown by Dr. Russell, this substance has a strong action on a sensitive photographic plate. The emanation from a bottle half full of hydrogen peroxide acts strongly on a sensitive film laid over the open mouth of the bottle for twenty-four hours, while there is no action in seventy-two hours if a U-shaped tube passed through the cork of the bottle and the sensitive film is put close to the open end of the tube. Dr. Russell tells me his observations confirm my experiments.

A highly active self-luminous radium compound loses some of its power on long exposure to the ordinary air of the laboratory. When inclosed in glass, the glass soon assumes a pink color. If, however, the radium compound is sealed in vacuo in a *quartz* tube, no coloration takes place, and I can detect no diminution of energy even in twelve months.

Electrons from radium will pass through aluminium and a considerable length of air and affect a sensitive film.* Experiments on this point were tried with polonium, and it was found that air offered great obstruction.

The electron theory explains a fact which has long puzzled experimentalists. It is well known that if a coin is laid on a sensitive plate in perfect darkness and connected with one pole of an induction coil for a few seconds and then developed, an image can be obtained of the raised parts of the coin. This has generally been explained by saying that the electrified stream of air, or the "brush discharge," affects the film like light.

But Mr. Sanford (Nature, vol. lv. p. 485) shows that coins embedded in the center of a block of paraffin 2 centimeters thick, where they could not send off streams of electrified air, can still be photographed by means of the induction coil. In these circumstances it is probable that electrons are the agents, as electrons will easily pass through paraffin wax from the coin to the sensitive plate, when the coin is connected with the negative pole of an induction coil, the other pole being connected with a metal plate placed below the wax block.

Hitherto we have been dealing with negative electrons—a free positive electron at present is unknown. In a paper communicated to the Royal Society, December, 1890 (Phil. Trans., 1901, A, vol. cxcvi. p. 525), the Hon. R. J. Strutt offers a suggestion as to positive ions which in a satisfactory manner appears to explain much that hitherto has been left doubtful, not to say contradictory.

He adopts the generally recognized theory that the deflectable Becquerel rays consist of a stream of negative corpuscles with enormous velocities proceeding from the radio-active body. But there are two kinds of Becquerel rays, one deflectable and penetrating, the other non-deflectable and easily absorbable. Mr. Strutt considers that these non-deflectable rays are positive ions moving in a stream from the radio-active body.

He says: "We know that the positive ions in gases carry the same charge as the negative, and that they have an enormously greater mass. Unless, therefore, their velocity is smaller out of all proportion than the negative ions, it is to be expected that they will be much less easily deflected by the magnet. . . . Next it may be noticed that the smaller penetrating power would be well accounted for by the size of the positive ions, which would, of course, make more collisions with the molecules of the surrounding gas than the much smaller negative ions."

Of the three radio-active bodies, radium, actinium and polonium, actinium appears to emit corpuscles almost entirely of the penetrating, deflectable kind, polonium rays of the non-deflectable, non-penetrating kind, while radium emits rays of both kinds.

On the above hypothesis, corpuscles from polonium might consist of the heavy positive ions: to test the accuracy of this inference experiments are now in progress.

Some curious and far-reaching inferences may be drawn from Mr. Strutt's view, supposing it to be correct, that positive as well as negative corpuscles will fly off from a radio-active body. In a paper "On Electrical Evaporation" (Royal Society Proceedings, vol. l, p. 88, June, 1891) I showed that many bodies, such as silver, gold, platinum, etc., usually considered non-volatile at ordinary temperatures, easily volatilize in a vacuum if connected with the negative pole of an induction coil, remaining fixed when connected with the positive pole. This phenomenon was first observed by Dr. Wright, of Yale College, and was applied by him for the production of mirrors for physical apparatus. It is shown by experiments that the action in the vacuum tube is of two kinds. A silver pole was used, and near it, in front, was a sheet of mica with a hole in its center. The vacuum was very high ($P = 0.00068$ millimeter), and when the poles were connected with the coil, the silver being negative, electrons shot from it in all directions, and passing through the hole in the mica screen, formed a bright phosphorescent patch on the opposite side of the bulb. The action of the coil was continued for some hours, to volatilize a certain portion of the silver. On subsequent examination it was found that silver had been deposited only on the mica screen and in the immediate neighborhood of the pole, the far end of the bulb,

* By Sir William Crookes, F.R.S. A paper read before the Royal Society on February 6.

† The body I called Uranium X in my Royal Society paper, May 10, 1900, has since proved to be M. Debierne's Actinium.

‡ The Photographic Journal, vol. xx. p. 86, December 21, 1895.

§ The opacity logarithm represents the density of the image, absolute density being represented by 2.00.

‖ The "opacity" is the whole number corresponding to the "opacity log." The "opacity" is directly proportional to the photographic energy acting on the sensitive surface.

* Using an active compound of radium, I have obtained an impression on a sensitive film, through a penny-piece.

at the spot which had been glowing for hours from the impact of electrons, being free from silver deposit. Here then are two simultaneous actions. Electrons, or, as I once called them, "radiant matter," shot from the negative pole and caused the glass against which they struck to glow with phosphorescent light. Simultaneously the heavy positive ions of silver, freed from their negative electrons, or under the influence of the electrical stress, likewise flew off, and were deposited in the metallic state near the pole.

During the course of my experiments a curious circumstance was observed, which deserves record as it may elucidate some of these obscure phenomena. While the volatilization of the silver pole is rapidly proceeding, the metal glows as if red-hot. This "red heat" is superficial only. The metal instantly assumes, or loses, the appearance of red-heat the moment the current is turned on or off, showing that the high temperature does not penetrate below the surface. The volatilization of the positive ions is confined to the surface and the surface glow is connected with that action. If instead of silver, a good conductor of heat, I take diamond, a bad conductor, the surface layers are changed sufficiently to convert them into a form of graphite, which from its great resistance to oxidizing agents cannot have been formed at a lower temperature than 3,600 deg. C.

PROF. J. J. THOMSON ON RADIO-ACTIVITY.

EXACTLY fifty years ago, at the first meeting of the British Association in the city of Belfast, Sir George Gabriel Stokes delivered, as one of the evening discourses, his famous lecture on "Recent Discoveries in Light." At that time the attention of physicists was closely directed to the curious action of certain bodies in emitting light at ordinary temperatures, and the main subject of Sir George Stokes' address was the then little understood phenomenon of fluorescence. It is a remarkable coincidence that the British Association, meeting after half a century in the same Irish city, should listen at one of the usual two evening discourses to a lecture by Prof. J. J. Thomson on the most recent researches tending to throw light on the true nature and cause of phosphorescence—viz., "Becquerel Rays and Radio-Activity." It is worthy of note, moreover, as Lord Rayleigh pointed out when proposing a vote of thanks to Prof. Thomson for his brilliant lecture, that the series of discoveries which were described in that lecture, and formed the clue to phosphorescence and much besides, have all been made within the past five years. Thus, although the essential phenomena of radio-activity have been known to physicists for at least fifty years, it is only within the last half decade that there has been any clue to their real cause. Doubtless much of this tardiness has been produced by too close an adherence to the undulatory theory of radiation, or, rather, from an unwillingness to perceive the consistency between this theory and the scorned emission theory in certain circumstances. It is indeed true, as Prof. Thomson observed during his lecture, that had the researches connected with radio-activity which have been made recently actually been made before the triumph of the undulatory theory, that theory would have had a very much harder fight for recognition.

Prof. Thomson traced the developments in radio-action research from the discovery of Röntgen rays down to the present time. It was the Röntgen ray which first gave the clue to the true action of uranium and other phosphorescent bodies, and it was Prof. Becquerel who first followed up this clue to a successful conclusion. Hence, the radiations or luminous emanations from uranium and other radio-active bodies were now called Becquerel rays. The chance event of a photographic plate, wrapped in light-proof material, being put away for several days in a dark drawer, in company with a piece of phosphorescing uranium salt, was the starting point of Prof. Becquerel's research. The phosphorescence had produced its effect on the plate, in spite of the darkness and the light-proof envelope. This pointed strongly to a resemblance between the phosphorescence and Röntgen rays, or some kindred emanation. Nevertheless, the actual piece of uranium salt used, having previously been exposed to ordinary light—in fact, to bright sunlight—was under suspicion of producing its photographic effect by virtue of this prior charging with luminous radiation. In other words, conclusive evidence was lacking that the uranium salt developed a self-originating radiation, and not a radiation due to previous exposure to light. Accordingly, Prof. Becquerel set about manufacturing some uranium salt which should never in the entire course of its existence be exposed to light. It was dissolved amid darkness; and in black darkness the crystals were formed and deposited. Undiminished in consequence, the phosphorescence still occurred, and the sensitive plate was affected as vigorously as if the uranium salt had been previously bathed in light. This experiment conclusively proved that the luminous emanations were self-originating and independent of any previous influence on the radio-active material.

Passing quickly in review, by aid of a few well-selected experiments, the most salient properties of radio-active bodies, Prof. Thomson was able toward the end of the hour allotted for his lecture to deal with some of the most recent researches and calculations. Unfortunately, the Grosvenor Hall, in which the discourse was given, although an admirable lecture hall from an acoustic point of view, is not well adapted to the exhibition of delicate experiments, and more than one of Prof. Thomson's elaborate and well-arranged experiments had to be abandoned in consequence. Little, however, was lost to the audience on this account, for the lecturer invariably made so clear what should be expected to take place that it was even as if it had actually happened. The diselectrification by the presence of radio-active matter was exhibited in a variety of forms, one experiment—which was quite a success—being Mr. C. T. R. Wilson's well-known fog experiment. The experiments of Rutherford in the deviation of this form of radiation by a magnetic field were also described. The lecturer then passed on to the important work accomplished by Prof. and Madame Curie, whose patient and laborious researches have imparted an immense stimulus to systematic inquiry into radio-active phenomena. These experiments are familiar to those of our readers who follow the records of radio-active research in these pages: the discovery that the Becquerel rays carry an electric charge, the detection of radio-activity in an immense number of rare earths and other bodies, notably—as being of such marked character—in pitchblende. Many of these bodies were found to exhibit a higher degree of radio-activity than even uranium, yet only so when they were in their natural state. Their artificial synthesis always yielded a substance possessing no marked radio-activity as compared with uranium. Suspicion at once naturally arose that there was some unknown substance present to which these minerals, in common with the uranium salts, owe their radio-active properties. Yet the spectroscope gave no indication whatever of the presence of any such substance. Long and patient research, with the pertinacity of a Sherlock Holmes, at length not only put Prof. and Madame Curie upon the track of the real substances giving rise to radio-action, but also allowed of their concentrating these substances. Three such substances have been detected—(1) the well-defined and isolable substance radium; (2) a less well-defined and but slightly recognizable substance called polonium, and (3) a vague and elusive substance called actinium. Of these three essentially radio-active substances, polonium and actinium have never been obtained in a sufficiently high degree of concentration to make their presence visible in the spectroscope. Only by the evidence of radio-activity can their existence be detected. Thus, as Prof. Thomson remarked, it is seen how much more delicate than chemical analysis, or even than spectroscopy, is radio-activity, as a test of the presence of these substances: "It is millions of times more sensitive than chemical analysis, and thousands of times more sensitive than the spectroscope." The percentage of radio-active matter in many instances in which these properties have been detected is "far less than the percentage of gold in sea water." Indeed, after Prof. and Madame Curie had detected radio-activity in pitchblende it became necessary to concentrate the essential radio-active constituent, radium, to no less than 5,000 times higher a degree of concentration, before even the spectroscope would give evidence of its presence. With such inconceivably minute traces of matter are we thus dealing, in the refinements of this fascinating research.

The question raises itself as to what is the rate, in measurable units, at which these self-originating emanations are constantly going on. There are two rates to be considered: first, the rate at which matter is being projected from the surface of the radio-active material; secondly, the rate at which energy is being given off in the process. Prof. Thomson's answers to these two questions caused his audience much astonishment. So slowly, in the case of pure radium for instance, is matter being thrown off by the radio-activity, that it would occupy one square centimeter of surface a million years to throw off only one-thousandth of a milligramme of the substance. Yet visible, not to say vigorous emanations are proceeding uninterruptedly from that surface. The energy thrown off is at a far more rapid rate, being sufficient, within the million years, to melt a layer of ice a quarter of a mile thick. It remains yet to be explained how the radium maintains its supply of intrinsic energy. Is it by virtue of the heat energy of its environment—some peculiar atomic constitution enabling it to absorb and transform that energy into Becquerel radiation? Or, is it by virtue of the normal electrification of its environment—the fact, in other words, that the earth and all upon it is negatively charged? Prof. Thomson, remarking on this latter point, mentioned that Messrs. Elster and Geitel have found that a negatively charged wire or pointed piece of metal is radio-active. In virtue of the earth's negative charge, moreover, all leaf tips and other points connected with earth are found to be radio-active. Another recondite matter in connection with radio-activity is its curious infectiousness, and the recovery in course of time of the infected bodies. Placed in contact with barium or thorium—or, indeed, almost any substance—a piece of radium will gradually impart to the neighboring substance its own radio-active properties, and, still more wonderful to relate, it will itself lose those properties. If now the two substances be separated for a time, it will be found that the barium will gradually lose the properties which contagion imparted to it, while, at exactly the same rate, the depleted radium will restore itself to its normal radio-activity. The entire series of operations may then be repeated many times over. Herein is a mystery which physical research is as yet unable to fathom. Prof. Thomson illustrated it in a homely manner. Imagine, he said, that all babies were radio-active from the moment they were born to the moment when they were 12 months old. Then, although there would be a continual supply of fresh babies, the radio-activity of the community would not, on the whole, greatly increase, for as many babies would pass out of the radio-active state as would be born into it. Now imagine that all the radio-active babies in the community at any given moment were to be removed to some place apart from the community. Then the community would for a time lose its radio-activity; but the *creche* to which the infants had been removed would glow with its newly-acquired radiation. In time, however, the old community would gradually acquire its lost radio-activity, for new babies would be born and cast their glow around; while, in exactly the same process of time the *creche* would gradually lose its radio-activity, for the infants would pass the age limit. The community is the radium, and the *creche* is the infected barium; but Prof. Thomson did not venture any further with his analogy. He refrained from giving any hint as to whether we are to infer therefrom that, like poets, "electrons are born, not made."—The Electrician.

To Clean Paint.—When painted work is badly discolored, put a tablespoonful of ammonia water into a quart of moderately hot water, and with the aid of flannel, wipe off the surface. Rubbing is not necessary. When the discoloration is not great, the following method is preferable: With a piece of clean flannel wet with clean warm water, and then squeezed nearly dry, take up as much whiting, of the best quality, as will adhere, apply this with moderate rubbing to the painted work, and afterward wash the surface with clean water, and rub it dry with chamois leather. This method is superior to the use of soap, requires but half the time and labor, and leaves the surface cleaned, looking as good as new. It will not injure the delicate colors.—National Druggist.

RATIOS OF THE ATOMIC WEIGHTS.

ARTHUR MARSHALL directs attention to the fact that when referred to the standard O = 16, many of the atomic weights approach whole numbers to an extent out of all proportion to the probabilities of the case. He also shows that very remarkable relationships exist in many cases between the atomic weights of allied elements. In the tables of the German Chemical Society eighteen atomic weights are given to two places of decimals, and, taking those, the author points out that the theory of probabilities shows the chances against their approaching as close as they do to whole numbers to be as high as 4120 to 1. If, on the other hand, the atomic weights are referred to H = 1, there appears to be little or no tendency to become whole numbers. But more striking relationships appear when certain of the atomic weights are referred to entirely different standards. Thus, the weights of the atoms of the halogen elements and silver are exactly in the ratio Cl : Br : Ag : I = 90 : 203 : 274 : 322. In the case of the alkali metals the proportions are even simpler, Li : NH, : Na : K : Rb = 7 : 18 : 23 : 39 : 85. Again, the horizontal series, V : Cr : Mn : Fe : Ni : Cu : Zn = 54 : 55 : 58 : 59 : 62 : 67 : 69. In conclusion, it is stated that there are evidently some unexplained irregularities in the ratios of the atomic weights, and that there appears to be a connection between the regularities and the phenomena of isomorphism.—Chem. Zeit.

A NEW PROCESS FOR TREATING FINE IRON ORES FOR BLAST FURNACES.

A PATENT was recently granted to Alexander D. Elbers for a process which has for its object to render rich, finely-divided iron ore more suitable for the production of pig iron in blast furnaces of large capacity, by converting it into clinker which will answer the purpose as hard lump ore.

Referring especially to the use in large quantities of the fine hematites of the Lake Superior districts—which becomes a necessity because the supply of lump ore does not equal the demand—their weight and exceeding fineness are sure to cause clogging, the ore becoming packed together so closely that the gases have no opportunity to work their way through the mass. In consequence, gas pockets are formed which explode, at times, with such force as to cause a large loss of both life and property.

Another drawback to the use of such fine ore is the large escape of ore-dust from the furnace-mouth, due to strong air-blast, the pressure of which must be increased in proportion to the size of the furnace if the latter is to be driven to its full capacity. This loss—which in 600-ton furnaces rises to 40 or 50 tons a day—can be considerably reduced by using briquetted ore instead of the loose, but that does not avert the danger of an explosion, because iron ore briquettes cannot be made to hold out under the pressure to which they become subjected in the blast-furnace. Every substance that can be used to make the particles of a mass adhere, when compressed at ordinary temperature or at a comparatively low heat, loses its binding force at, or even below, full red heat; and the rich hematites do not begin to frit at that temperature, even when they are mixed with lime. Hence all such briquettes, instead of remaining whole until they melt down, are bound to crumble and spread while passing through that zone of the furnace where the formation of gas pockets is apt to lead to the most disastrous results. If, on the other hand, the fine ore is fritted to hard lumps in an intense heat before it is charged into the blast-furnace, those lumps may become sufficiently tough to hold out until they melt down; and that is what the writer claims can be accomplished by his invention.

The invention consists in intimately mixing the ore with moderate quantities of pulverized slag of suitable composition, and in burning the mixes to clinker in rotary kilns of the cement burning type. The modus operandi will be practically the same as in burning dry cement-mixes. But the cement-clinker issues from the kiln in particles usually varying from pea to hazel nut size, whereas the ore-clinker is apt to range from walnut to egg size, and for the following reason: The forming cement-clinker shrinks considerably because all of its constituents are chemically active from first to last, and as this shrinkage gradually progresses from the surface to the interior of its mass, it breaks up into smaller pieces. The iron ore, on the other hand, undergoes but little chemical change during the burning, the change being chiefly confined to the combination of some of its earthy constituents with portions of the admixed flux. If this flux melts quite liquid at the temperature of the kiln, and if the compounds that it forms with portions of the gangue become also more or less thin fluid, then the ore-mix is apt to agglomerate in the same manner as a rolling snowball until the lumps thus formed become too heavy to hold together. Furthermore, if the flux is of the right kind—which may be learned from the patent specifications—the resulting clinker is apt to be so uniform and tough as to be even preferable to lump-ore, which always decrepitates more or less.

As to the cost, prominent specialists in the installation of rotary cement-kilns have expressed the opinion that under favorable conditions for flux and fuel, 60 per cent ore can be converted into sound clinker at about 80 cents per short ton of pig made exclusively from such clinker. But even $1.50 would be cheap.

While the process has not yet been practically demonstrated, the results of the preliminary tests are of such a nature as to convince any competent metallurgist that sound iron-ore clinker can be made in the manner described.

DISAPPEARING GUNS.

In former times ships of war were not anxious to engage in a contest with coast forts and batteries, since, being constructed of wood, they could only get the worst of it. It was for this reason that, during the First Empire, the numerous English fleets, although mistresses of the sea and capable of attempting attack after attack upon the French coast, nevertheless abstained therefrom. Napoleon, in fact, had bestudded the maritime frontiers with numerous defenses capable of making the enemy repent of his aggressions. There came a time, however, when ships seemed to assume a pre-eminence over coasts, and this was when they were provided with an armor that almost perfectly protected them against the effects of projectiles, although it is true that at that period coast batteries were furnished with guns that were inadequate and, for the most part, old-fashioned.

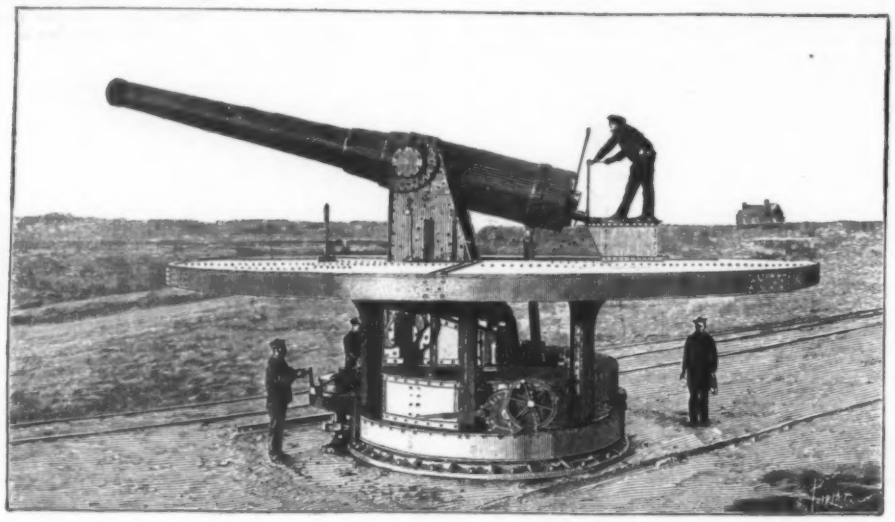


FIG. 1.—SCHNEIDER 10.5-INCH DISAPPEARING GUN IN BATTERY.

At present, such is no longer the case. Coast fortifications are now provided with guns which, if not equal to those that constitute the armament of vessels possess at least a power fully sufficient to put the latter *hors de combat*. Moreover, the accuracy of firing is not the same with the ship and the coast guns, the advantage being entirely on the side of the latter. The regulation of the firing from land has even made such progress that it may be asserted that a vessel happening to try its mettle with a coast battery would be struck by the third shot at the least, and continue to be struck by the succeeding ones. So it may be said that the contest between marine gunners and coast artillerymen has finally returned to the point where it was a century ago; that is to say, wholly to the advantage of the latter.

Such superiority of the land over the sea is capable of being still further increased by various arrangements, and, among these, the best, undoubtedly, is that whereby the gun is concealed from the sight of vessels. What sort of a shot, in fact, can the latter direct against an invisible target, without any data for effecting the corrections that are always necessary? Now, there are two kinds of batteries that realize the conditions of fighting without being seen. There are, in the first place, underground mortar and howitzer batteries that fire indirectly at wide angles, and, in the second, disappearing gun batteries. In the first, the guns remain wholly invisible, and their firing, which is done at wide angles, is necessarily imperfect. In the second, the piece appears only just at the instant at which it is fired, and then immediately disappears; and with the use of smokeless powder it would be almost impossible for ships to determine the position of the battery that fired the shot. Even should they succeed in obtaining a glimpse of the gun during the short interval of its appearance they would hardly be any better off.

Disappearing guns, then, are formidable weapons, and the more so in that they fire direct shots which are capable of striking a vessel at the load water line and consequently of sinking her. Among the most remarkable guns of this kind may be mentioned the one recently constructed by Messrs. Schneider & Co., which we illustrate herewith.

This gun is of 10.5-inch bore; its length is 25.19 feet; and its weight is 48,477 pounds. The breech block is of the Schneider-Canet type, with plastic obturator, the opening and closing of which are effected by turning a crank.

This weapon has a chamber-length of 28 calibers. The initial velocity of its projectile is 2,198 feet, which is quite sufficient for a coast gun using a 475-pound shell. The charge is 90 pounds of smokeless powder.

The gun is carried by a strongly cross-braced "rocker," which oscillates around a rotary axis formed of two trunnions that support the brackets of the frame-platform. This latter receives all the parts of the carriage, which consist of the cylinders of the brake and of the air recuperator, the pointing devices, and the pump for putting out of battery. It rests upon the bolster through the intermedium of a circle of rollers and supports, by means of a number of uprights, the horizontal circular mask. This latter is provided with a longitudinal aperture designed to give passage to the gun in the disappearing and returning to battery motions.

To the rocker is secured the piston rod of the hydraulic brake, which has a counter rod that absorbs a portion of the live force of the recoil. The brake cylinder is capable of oscillating around two journals carried by the iron plate floor through the intermedium of two pillow blocks. In the rear of the brake cylinder is situated the air recuperator that assures the return to battery.

The upward pointing of the gun is obtained by acting upon a jointed rod that sustains the rear end of the piece. The pointing sector is controlled by a crank, and an index that moves over a dial permits of reading at every instant the exact angle made by the axis of the gun with the horizontal.

The pointing in direction is obtained by making the platform, rocker, and gun as a whole turn upon the bolster. In normal service, the direction of the piece is given in the complete disappearing position; but, since it may be necessary to rectify the pointing, even after the gun has returned to battery, the mask is provided with a special platform that permits the gunner through the breech sight, to aim directly at the object to be fired at.

FIG. 2.—THE GUN AFTER FIRING.

The amplitude of the vertical pointing extends from +15 deg. to —5 deg. As for the amplitude of the lateral pointing, that extends over an entire revolution so as to permit of sweeping every point of the horizon.

The weight of such an affair is not as great as might be supposed at first sight. The gun (as has been stated) weighs 48,477 pounds, the carriage 95,270 and the mask 39,600, say a total of 183,347 pounds.

As the advantages of their eclipse gun, Messrs. Schneider & Co. enumerate the following: First, its power is sufficient to permit it to do battle at a great distance with heavily armored vessels. Second, the complete protection that its mask assures it places it under very advantageous conditions for prolonging a contest. Third, as the gun disappears after every shot and the use of smokeless powder does away with a cloud of smoke that might attract attention, the enemy will find it very difficult to discover the sight of the battery. Fourth, the well directed shots of the enemy will produce but little or no effect, since they will reach the horizontal mask with too slight an inclination to perforate it. Fifth, since the personnel and entire mechanism are placed beneath the mask, the gun will be able to keep up a lengthy contest without sustaining any serious loss or damage.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

THE DEVELOPMENT OF THE GERMAN CHEMICAL INDUSTRY.

PROFESSOR James Dewar, the English scientist, famous for his researches into the liquefaction of gases, and the attendant phenomena, opened his presidential address to the British Association with a review of the development of the chemical industry of Germany. A short time ago, a well-known American writer, in the course of an historical survey of the British Institution, described how this organization assists in investigations and researches in the various ramifications of science. Professor Dewar illustrated this fact by reviewing the sums of money that had been expended by this Society during the nineteenth century, in the interests of science. The salaries of the professors of physics and chemistry, with their assistants, and the cost of their laboratories, came to $503,100, to which must be added a special fund of $47,900, contributed by friends for special experimental research; and as Faraday enjoyed for 32 years a civil life pension of $1,500 a year, a further sum of $48,000 must be added, bringing the total up to $599,000, just under $6,000 a year. Among those obtained for this expenditure were Young, Davy, Faraday and Tyndall. Professor Dewar then passed on to review the manner in which England has neglected science in education, and its consequent results upon the prosperity of the country in various directions. He cited an able illustration of the result of this neglect in the chemical trade of Germany. In the year 1901 there were no less than 4,500 trained chemists employed in German works; 25 years ago the number was only 1,700. The number of persons employed in the same industry in Great Britain to-day does not exceed 2,000. In addition to this startling fact the German chemists are, on the average, far superior in acquirements and technical training to British workmen in like positions. Of 633 chemists employed in German works, 84 per cent have received a thoroughly systematic and complete chemical training, and 74 per cent hold the degree Ph.D. Of 500 chemists in British works, only 21 per cent are graduates and about 10 per cent hold the diploma of a college. In other words, only 31 per cent have had any systematic training. The history of a single firm serves as an example of the pecuniary results which have followed an intelligent appreciation of a sound and thorough education. The firm of Friedrich Bayer & Co., is engaged in the production of drugs, perfumes, and coloring matters from coal tar, and it employed in 1875, 119 workmen. The number has more than doubled itself every five years, and in May of this year the firm employed 5,000 workmen, 160 chemists, 260 engineers and mechanics and 680 clerks. For many years past it has regularly paid 18 per cent on its ordinary shares, which this year has risen to 20 per cent; and, in addition, in common with other and even larger concerns in the same industry, has paid out of profits for immense extensions usually charged to capital account. There is one of these factories, the works and plant of which stand in the books at $7,500,000, while the money actually sunk in them approaches to $25,000,000. In other words, the practical monopoly enjoyed by the German manufacturers enables them to exact huge profits from the rest of the world, and to establish a position which, financially as well as scientifically, is almost unassailable. Curiously enough the fundamental discoveries upon which this gigantic industry is built were made in Great Britain and were practically developed to a certain extent by their authors. But, in spite of the abundance and cheapness of the raw material, and in spite of the evidence that it could be most remuneratively worked up, these men founded no school and had practically no successors. The colors they made were driven out of the field by newer and better colors made from their stuff by the development of their ideas, but these improved colors were made in Germany and not in England. The explanation of this extraordinary and disastrous phenomenon is simply want of education. Although the United Kingdom had the material in abundance when other nations had comparatively little; had the capital, and the brains, it did not possess the diffused education without which the ideas of men of genius cannot fructify beyond the limited scope of an individual. It is the want of education among the so-called educated classes, and, secondarily, among the workmen on whom these depend, which is the root of the evil. It is in the abundance of men of ordinary plodding ability, thoroughly trained and methodically directed, that Germany at present has so commanding an advantage. But, at the same time, Professor Dewar emphasized that it must not be imagined for a moment that this deficiency can be remedied by any amount of that technical training which is now the fashionable nostrum. It is an excellent thing, no doubt, but it must rest upon a foundation of general training. Mental habits are formed for good or evil long before men go to the technical schools. To his mind the really appalling thing is not that the Germans have seized this or the other industry, or even that they may have seized upon a dozen industries. It is that the German population has reached

a point of general training and specialized equipment, and possesses a national weapon of precision, which must give her an enormous initial advantage in any and every contest depending upon disciplined and methodized intellect.

GYMNASTIC EXERCISES OF THE 12TH REGIMENT OF ITALIAN SHARPSHOOTERS.

CLIMBING exercises were introduced this year at Brescia. For the first exercise the men had to climb the counterscarp of the foss; for the second, the wall of the city—26 feet high—and then, encouraged by the results thus far obtained, the scaling of the castle wall—56 feet high—was attempted and successfully accomplished. This constituted the third and fourth exercises. The feats were performed by the entire force of all of the companies, some of the sharpshooters being armed with guns, while a few were fully equipped. All climbed without assistance to the projecting portion of the wall, clutching any rough or uneven portions, but above that two or three of the strongest and most daring prepared the way for the others by driving spikes here and there, to be grasped or stepped upon by those who followed, where the wall offered no such support. When they reached the top they threw down ropes to aid or serve as safeguards for those who were less daring or not so strong. But these ropes are no longer needed. The exercises have greatly improved the physical and moral fiber of the men, for while inculcating courage, they provide efficacious and practical moral instruction. It is, of course, unnecessary to say that the officers always set a good example to their men.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from L'Illustrazione Italiana.

THE TEXAS-LOUISIANA OIL FIELD.

A BULLETIN soon to be issued by the United States Geological Survey, contains a report by Dr. C. W. Hayes and Mr. William Kennedy on the Texas-Louisiana Oil Field, which is of particular interest at this time.

From the Mississippi River westward through Louisiana and Texas to the Rio Grande, along the border of the Gulf of Mexico, and extending inland for from 50 to 100 miles is the Gulf Coastal Plain. The existence of petroleum in this part of the country has been known as far back as 1860. Since the beginning of the present oil development, the coastal plain has been examined, and its general underground condition to a depth of about 2,000 feet has been brought to view, although many questions as to underground structure remain unanswerable until further drilling.

A generalized geologic description of the formations of the Gulf Coastal Plain is given, and is followed by detailed descriptions of sections of the coastal plain formations, including the logs of a number of the wells drilled in the region.

The geology of the oil pools, which, so far as they are now known, occupy an extremely small fraction of the region described, is discussed. The districts discussed are: In Texas, Beaumont district, Sabine Pass district, Sour Lake district, Saratoga district, Dayton district, High Island district, Columbia district, minor Texas districts; in Louisiana, Jennings district, Ansa la Butte district, Sulphur district, Vinton district, Hackberry Island district, minor Louisiana districts.

With regard to the Spindletop oil-rock, the report states that its exceptional character explains in a measure the remarkable features of the Spindletop pool. Its extreme porosity favors the storage of a very large volume of oil, and also favors the yielding of this oil with very great rapidity when the reservoir is tapped. It also favors the early exhaustion of the oil in the pool, and its rapid replacement by the underlying salt water. Beds of sulphur-bearing sand are reported from some of the wells on Spindletop, and beds of gypsum and of salt from others.

A list is given of 280 wells in the Spindletop pool which have shown a yield of oil sufficient to be considered of commercial importance. The list was completed, as far as possible, up to June 15, 1902. The structure of the Spindletop pool appears to be that of a dome with steep sides and rather flat summit. Judging from the normal thickness of the Gulf Coastal Plain formations, and from the structure of the Spindletop pool, it seems evident that a well in this region less than 3,000 feet in depth does not reach the oil-bearing horizon anywhere except upon the Spindletop dome. The shallow dry wells already drilled outside of Spindletop prove but little. One co-operative test well put down at some carefully selected locality to a depth of 3,000 or 3,500 feet would probably be of much greater value than a large number of shallow wells put down in various localities.

As shown upon the map accompanying the report, the indications point to the possible development of oil along the following lines, all running northeast and southwest: A line from Damon, in Brazoria County, Texas, through Dayton to Saratoga, in Hardin County; a line from Big Hill, in Matagorda County, through Columbia to Sour Lake, in Hardin County; a line from High Island, in Galveston County, through Big Hill to Beaumont, in Jefferson County; a line from Sabine Pass, in Jefferson County, Texas, through Vinton to Sulphur, in Calcasieu Parish, in Louisiana; a line from Hackberry, in Cameron Parish, to Spring Hill, in Calcasieu Parish, Louisiana. The well-known oil "ponds" upon the surface of the water point strongly to a source of oil near the south end of the west jetty in the Gulf, at Sabine Pass.

With regard to the origin of oil in the Gulf Coastal Plain, the report discusses briefly the obscure geological problem of the origin of petroleum in general: (1) According to one theory which explains the origin of oil by inorganic agencies, water percolating downward through fissures in the earth's crust comes in contact under conditions of high temperature and great pressure with metallic carbides, and the resulting chemical reaction produces metallic oxides and saturated hydrocarbons, the latter ascending and impregnating porous beds of sedimentary rocks in which they are now found. No geological evidence is at hand that these reactions actually take place in the earth's crust. The inorganic theory is attractive but not proven. (2) According to the theories of organic origin, first, petroleum is indigenous to the rocks in which it is found and results from the primary decomposition of organic matter, and was formed when the rocks themselves were formed; and, second, petroleum is derived from the organic matter disseminated through great masses of carbonaceous shales by the process of slow natural distillation at low temperatures, and that it has subsequently migrated through the strata to the reservoirs in which it is now found. The majority of geologists have held to this second theory, but the possibility of natural distillation at a temperature sufficiently low to leave the enclosing rocks entirely unchanged has not been proven, nor have the residues of carbon which would result from such distillation been found in the rocks. (3) According to theories involving both inorganic and organic agencies, petroleum is produced by the action of volcanic gases containing sulphurous acid and hydrogen sulphide upon limestone (containing vegetable or animal matter), on the one hand, or upon gypsum, on the other. This great diversity of views regarding the origin of petroleum is equaled by the diversity in the character of the petroleum itself, and in the geologic condition under which it is found. It is, therefore, probable that the final theory of its origin will recognize the fact that petroleum may be the product of widely different processes acting upon a great diversity of materials. The petroleum of the Gulf Coastal Plain is probably derived, in part at least, from the action upon gypsum of decomposing organic matter, both animal and vegetable, but chiefly the latter.

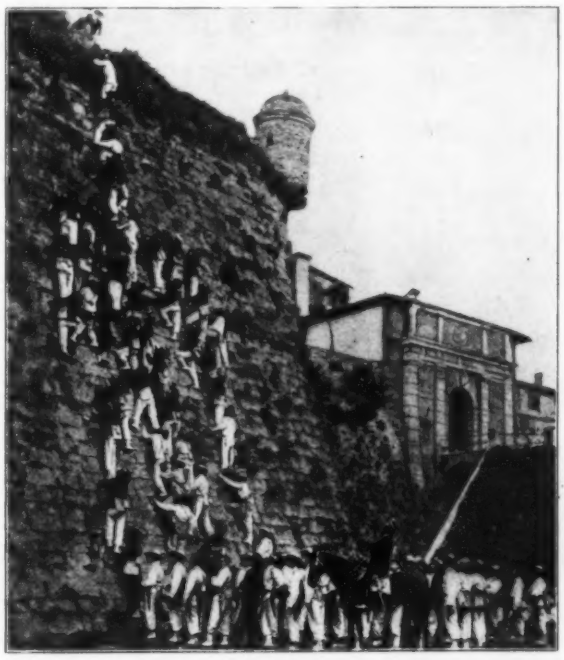
The essential conditions for the accumulation of oil are: (1) A sufficient supply of oil derived from any of the sources above described, (2) a porous reservoir rock in which it may be stored, and (3) an impervious cap rock which will prevent its escape. Conditions which favor its accumulation, but which are not always essential, are: (4) Gentle undulations in the strata, forming anticlinal arches, or domes; and (5) the complete saturation of the rocks with water, and its slow circulation under hydrostatic head, or convection, due to differences of temperature. An abundance of organic material and conditions favorable for its conversion into petroleum have been notably present in many thousand feet of strata constituting the Cretaceous and Tertiary formations of the Gulf Coastal Plain. There are present, also, in the coastal plain an abundance of reservoir rock to hold the oil, of impervious cover to prevent its escape, and a rock structure favorable to the accumulation of oil in pools. It is thought that, although most of the oil has remained disseminated through the beds of the coastal plain, much of the petroleum has been enabled to overcome the obstacles occasioned by the irregularity in the character of the beds, and to collect in pools by means of the saturation of the rocks and the circulation of the water contained in them. This agency of circulating waters explains, it is thought, the accumulation not only of the oil in the coastal plain pools, but also of the sulphur and salt associated with it.

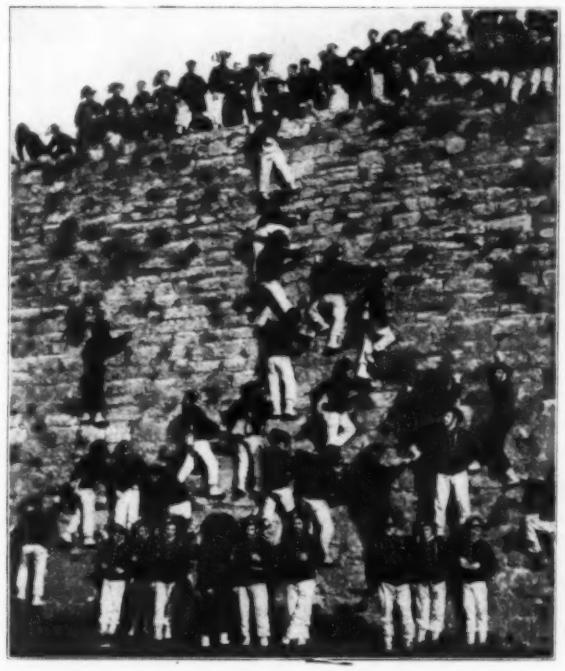
After discussing the way in which the sulphureted hydrogen gas affects the flows of the different wells in the coastal plain, and its agency in producing large deposits of sulphur in various localities, the report takes up the probable duration of this petroleum belt. Without attempting any positive prediction, the conclusion is reached with regard to the Spindletop field that the Spindletop oil rock contains about one-fourth of its volume of oil, that is, a cubic foot of oil rock may be considered as holding one-fourth of a foot of oil, or .87 of a gallon of oil at complete saturation, and a barrel of 42 gallons will be obtained from about 24 cubic feet of rock, allowing for the proportion unavailable. Even if we make the estimate at 1 barrel for every 26 cubic feet for Spindletop, and a little less for other fields, we should have a yield equal to the Baku field in Russia, and a much greater output than that of any of the other American fields. The yield of the Baku fields has been estimated to equal about one-fifth of the volume of the rock. The petroleum stored in the Trenton limestone, one of the best producing limestones in America, has been estimated at about 10 per cent of the rock, and the statement is made that small portions of the best Pennsylvania fields have yielded 900,000 barrels per square mile.

Petroleum does not exist in unlimited quantities anywhere. The supply is practically limited to the contents of the field, as we find, and when this has been withdrawn no more is obtainable. Spindletop forms no exception in this inflexible rule, and the length of time that even this great field may continue to produce oil is altogether dependent upon the number of wells draining the pool.

A discussion of the physical and chemical properties of this Gulf Coast petroleum leads up to the apparent consensus of opinion among the chemists who have examined it that it is unsuited for the production of illuminating oil, and that it is doubtful if it can be made to yield a good lubricating oil on a commercial basis. Its value as a source of asphalt and as a gas oil is, as yet, undetermined. With regard to the successful use of this oil as a fuel, the experiments made by Professor Denton in the plant of the West Side Hygeia Ice Company, of New York, and by the Southern Pacific, and the Gulf, Colorado and Santa Fe railroads, seem to establish both its availability and its economy as a generator of steam. Whether the Beaumont petroleum may be successfully used in metallurgical processes is not yet settled.

When properly burned, the flame of the petroleum is a clear white with an intense heat, and as the fuel is completely consumed no smoke issues from the smokestack. When improperly handled, however, an intensely black smoke pours from the smokestack in great volumes, smutting and spoiling clothes and paint work, and covering everything it touches with a black, greasy soot. On the whole, Beaumont petroleum may be considered as a valuable fuel even in its crude state, and when deprived of some of its lighter constituents it will be quite as safe as any other liquid fuel now on the market. In some re-





GYMNASTIC EXERCISES OF THE TWELFTH REGIMENT OF ITALIAN SHARPSHOOTERS.

spects it is inferior to the Pennsylvania and Russian oils, but its evaporative power is higher than that of the Virginia and California oils. Compared with various coals, including Pittsburg lump and slack, anthracite, Indiana block, Georges Creek lump, Maryland, Pocahontas, Virginia, Cardiff lump, Wales, Cape Breton, Canada, the number of barrels of Beaumont petroleum required to do the same amount of work as a ton of coal, ranges from 3.4 barrels to 4.3 barrels.

At present there are four pipe lines to Port Arthur, and two to Sabine Pass, whence shipments are made chiefly to New Orleans, Mobile, Philadelphia, and other coast harbors, and considerable quantities are shipped also to European ports in tank ships.

The combined tankage of steel and earthen tanks at Beaumont is, at the present time, about 7,500,000 barrels.

The method of drilling wells in the Beaumont and contiguous oil fields is the rotary process, which is described at length. Prices for drilling wells vary in accordance with the conditions of the contract, but from $4 to $4.50 per foot of depth may be considered a fair average of prices to-day, the contractor furnishing all tools, machinery, labor, etc., necessary to drilling the well. The company usually reserves the right to accept or reject the work upon completion. The average time required to drill a well in any of the oil fields, when no accident occurs, is about two months. Considerable danger accompanies the flowing and the closing of a new well on account of the poisonous nature of the gas accompanying the oil flow. This gas contains a large proportion of hydrogen sulphide, and its poisonous qualities are intensified by its being saturated with petroleum vapor. Petroleum vapor has the effect of rendering people inhaling it unconscious, and if the patient remains under its influence for any length of time, death ensues. The combination of the hydrogen sulphide and the petroleum vapor issuing from the wells of Beaumont is such as to render death almost instantaneous, although, fortunately, few fatal accidents of this kind have taken place at Spindletop.

An estimate of the maximum flow of 162 wells now in use at Spindletop may be made as somewhere between 25,000 and 30,000 barrels daily; probably the average flow would not exceed 10,000 to 12,000 barrels.

The total production of crude petroleum in the Beaumont Spindletop field, including the oil wasted from wild gushers and from other wells, the local consumption, the oil held in tanks, and the oil shipped away, from the beginning of 1901 up to May 31, 1902, is estimated at 11,688,000 barrels. The value of well material, tanks, tank cars, pipe lines, pumping stations, refineries, and wells producing, drilling, and abandoned, is estimated at about $7,640,000. On December 31, 1901, the number of wells abandoned was 28; of producing wells, 131; and of wells drilling, 46; a total of 205. On May 1, 1902, there were 52 abandoned wells, 240 producing wells, and 60 wells drilling; a total of 352—an increase on May 1, 1902, over December 31, 1901, of 24 abandoned wells, 109 producing wells, and 14 drilling wells; a total of 147.

[Continued from SUPPLEMENT No. 1401, page 22451.]

REPORT OF BUREAU OF STEAM ENGINEERING ON LIQUID FUEL FOR NAVAL PURPOSES.

THE VOYAGE OF THE S. S. "MARIPOSA," USING AN OIL-FUEL INSTALLATION EXCLUSIVELY UNDER HER BOILERS.

THE following is a description of the steamer "Mariposa," of the Oceanic Steamship Company, as fitted for oil-fuel burning, with an account of the preliminary trial trips of the vessel as witnessed by Commander H. N. Stevenson, United States Navy; also the report of Lieut. Ward P. Winchell, U. S. Navy, who officially represented the Department on the round trip of the steamer between San Francisco and Tahiti.

The "Mariposa" is a single-screw iron steamer, built at the yard of William Cramp & Sons, Philadelphia, Pa., in 1883. She has just had new engines and boilers installed by the Risdon Iron Works, San Francisco, Cal. The oil-burning plant has just been installed by the same company.

This vessel has been employed in the Pacific trade, and is now running to Tahiti from San Francisco, making the round-trip voyage of 7,320 knots each month.

DESCRIPTION OF THE "MARIPOSA."

Gross tonnage		3,160
Length between perpendiculars	feet	314
Beam	do	41
Mean draft	do	22
Depth of hold	do	17 3-12

There is a single bottom with four water-tight athwartship bulkheads, and two masts, square rigged on the foremast.

The total crew was formerly 81, but since the change from coal to oil burning 16 men have been taken out of the engineer's force, reducing the crew to 65 men and making the engineer's force for oil burning 20 men, as follows: 1 chief engineer, 3 assistant engineers, 3 oilers, 1 electrician, 1 attendant for ice machine, 1 attendant for air compressor, 3 water tenders, 6 firemen, 1 storekeeper; total, 20.

The Engines and Boilers.—There is one triple-expansion engine of the inverted direct-acting type, with cylinders 29 inches, 47 inches, and 78 inches by 51-inch stroke, designed for 2,500 indicated horsepower, fitted with piston valves on the high pressure and intermediate pressure, and slide valve on the low-pressure cylinder, all driven by link motion. The condenser is part of the back framing. The cylinders are not jacketed.

The air, feed, and bilge pumps, of which there are two sets, are driven from the forward and after crossheads. The centrifugal circulating pump is driven by a separate engine. The 4-bladed propeller is 16 feet 6 inches diameter and has a pitch of 23 feet.

There are three cylindrical tank boilers placed fore and aft in the line of the ship—two are double ended, 15 feet 3 inches diameter by 17 feet 3 inches long, and one single ended, 14 feet diameter by 9 feet 9 inches long, the latter placed amidships, forward of and worked from the forward fire room. Each double-ended boiler has six corrugated furnaces; the double-ended boilers have a common combustion chamber for opposite furnaces, while the single-ended one has a common combustion chamber for its three furnaces. There is one smokestack for all the boilers. The combustion chamber for the double-ended boilers have a brick bridge wall, and the back sheet of the single-ended one is covered with fire brick. The decision to use oil in place of coal was not made until the changes in engines and boilers were well under way, and it was decided to put the ship on the route to Tahiti. The steam pressure is 180 pounds. There is one auxiliary boiler, two-furnace return-tube type, in upper fire-room hatch, and fitted to burn coal only.

The Oil Tanks.—These were constructed out of the old coal-bunker space forward of the boilers, and as the steamer is intended to carry oil for the round trip of about 7,320 miles some additional space had to be taken from the fore hold. They are arranged as follows: Just forward of the boiler space a solid water-tight bulkhead, well braced, was built from the berth deck to the single bottom of the ship, extending to the single skin of the ship, from side to side; 4 feet, or two frame spaces, forward of this was also built another similar solid bulkhead, which formed the after ends of the oil tanks; 48 feet farther forward another similar solid bulkhead was built to form the forward ends of the oil tanks, and 4 feet forward of this another solid bulkhead. The spaces of 4 feet at each end of the tanks being a cofferdam space to catch any oil from leakage or accident; these cofferdam spaces can be filled with water if necessary. The tank space is divided into six tanks by a middle bulkhead and two side partitions. Splash plates to break the impact of rolling are placed in each tank, a small opening at the top allowing any accumulation of gas to pass off to ventilating trunk. Small openings at the bottom allow free communication for the oil. Along the top of the tanks is provided an expansion head or trunk, being 4½ feet high and 4½ feet wide. Over each a ventilating trunk connecting with the top of each tank extends up to about 5 feet above the hurricane deck. The cofferdam spaces are ventilated by tubes reaching to the upper deck, fitted with cowls, one tube reaching to near the bottom to carry off any heavy gas that might accumulate there. From the upper deck the sounding pipes to each tank are reached. There are no pipes in or through the tanks except those connected with the oil service. The total capacity of the tanks, exclusive of expansion trunk, is 6,338 barrels of oil—about 905.43 tons. One barrel of oil equals 42 gallons.

To fill the tanks on the port side outside the ship a 6-inch hose connection is fitted; from this a pipe leads to the forward fire room where the tank oil pump is placed. This pump, horizontal duplex, steam cylinders 9 inches, oil cylinders 8½ inches, stroke 10 inches, can be used to draw its supply from the pipe and deliver into each of the tanks, or by using by-passes, which are provided, the oil barge alongside can fill all the tanks; an overflow pipe from each tank, carried at height of the deck above them, leads to an overflow outside the ship near the supply-hose coupling.

There are two service or settling tanks placed in pockets formed on either side of the single-ended boiler. They are reached by doors from the forward fire room; each of these tanks holds about twelve hours' supply. They are filled by the oil-tank pump and have overflows back to the main tanks; ventilating tubes lead from near the bottom of the pockets in which they are placed to the smokestack.

Each service tank is provided with glass gages by means of which the amount used every hour or watch can be easily measured.

Each settling tank has two suction pipes, one at bottom to draw off water if necessary, the other at a height of about two feet for the oil supply to the service pumps. All the tanks are provided with manholes to reach the interior.

The Oil-Service Pumps.—The oil-service pumps, of which there are two, horizontal duplex, steam cylinders 6 inches, oil cylinders 4 inches, and stroke of 6 inches, one being large enough to supply all the burners, are placed in the forward fire room on either side. They draw their supply from the settling or receiving tank through removable strainers placed so they can be easily changed for cleaning, and discharge into the bottom of the small heating tank near them where the oil is heated by a steam coil to not more than 150 deg. F., and thence by a pipe to the burners. The air from the compressors, under a pressure limited to 40 pounds, discharges into the top of the heater tank on its way to the burners, so that the oil and the air go to the burners under the same pressure. The heater tank is provided with glass gages, also a float to work a telltale and automatic control of oil-supply pump.

The Air Compressor.—The air compressor is placed in a pocket off the upper engine-room platform, and consists of duplicate steam and air cylinders connected to a crank shaft carrying a fly wheel turning between the cylinders. Either set is large enough to supply all the air necessary. The air compressor is horizontal, double-acting, duplex. Air cylinders 22 inches, steam cylinders 12 inches diameter, by 18-inch stroke for all cylinders. Capacity equals 1,000 cubic feet per minute compressed up to 30 pounds at 120 revolutions per minute. Air is used at the heat of compression, or as heated by the air heater.

The Atomizer.—The atomizer, for which patents are pending, is the joint invention of Messrs. Grundell and Tucker, San Francisco.

The atomizer consists of a hollow plunger for the oil, screwed into a pipe through which the air passes. The outlet for the oil is through a series of small holes at right angles to the central hole; the air meets the oil through spiral directors and is sprayed into a rose shape by the expanded end of the atomizer.

The air and oil pipes have globe valves to regulate the supply of either, also plug cocks connected together to a handle by means of which each burner can be shut off immediately, in case of necessity, a slow-down bell, or other cause. The air-supply pipe is also connected to the steam line so that steam can be quickly substituted for air, if desired. The length of the oil plunger is adjustable, to give the best form to the rose-shaped flame. Two burners are fitted to each furnace.

The Air Heater.—A part of each furnace front is a hollow iron casting through which the air passes on its way to the atomizers and becomes heated. The chamber surrounding the burner is lined with a crucible lead lining; a by-pass to the burner is provided for use in case of accident to the heater. The lower part of the furnace front is a door on hinges that can be fastened open at any desired degree to give air for combustion. There are also two louvres in the door for the same purpose. Near the front of the furnace inside the door is placed a brick wall made to deflect upward the inward current of air to meet the rose-shaped flame from the burners. There is ample space over the brick wall for a man to enter the furnace through the ash-pit door. The double furnace combustion chambers have a brick bridge wall reaching above the top of the furnaces, and in the single-ended boiler the common combustion chamber has the back sheet covered with fire brick to protect it.

The Trial Trips.—Two trial trips with the vessel under way were made on July 5 and 11, the vessel being under way about eight hours each day, running from the vessel's dock to the Farallone Islands and return, and were made for the purpose of ascertaining if the oil apparatus, the new engines and boilers, were in good working condition. On the first run the boilers primed badly, owing to the construction dirt not having been thoroughly cleaned out. Before the second run they were cleaned and worked well on this run.

The strainers on the oil supply pipes were not finished and considerable trouble was found with dirty oil which clogged the burners. Neither the telltale to show the height of oil in the heater tank, nor the controlling device for the oil-service pump were fitted, not being finished in time for use. No attempt was made to measure the amount of oil burned, nor to attain the maximum speed, and it was therefore impossible to obtain any data other than observation of the working of the oil apparatus.

Very few of the fire-room force had ever had any experience with oil burners on steamers, and one object of the trials was to give the force practical experience. When properly regulated the burners gave no smoke, but that they were not properly regulated is shown by the fact that more or less smoke was visible most of the time, and at times dense black. Owing to lack of the telltale and regulating device of the small heating tank the pump tender once allowed this tank to fill up and the oil to flow over into the air pipe and flood the burners. As soon as this was discovered every burner was immediately shut off by means of the lever connecting to the plug cocks on the oil and air supply pipes at the burners.

The atomizer tubes were unscrewed and on some of them, where the oil had caked, considerable force had to be applied to pull them out. New, clean atomizers were screwed in, and as soon as the oil-heater tank could be brought to the proper oil level the burners were started again. Some steam pressure was lost during this delay, but the engines did not stop nor slow down very much; some of the burners were started in a few minutes, and all of them in not over fifteen minutes. The value of being able to shut off the oil and air quickly and clean or substitute other atomizers was shown by this mishap. The burners made considerable roaring noise, and the air pressure was, in order to clean the burners from dirt, carried at about twice the intended pressure, owing to the lack of the strainers, which allowed dirty oil to choke them, and they had to be taken out frequently for cleaning. By shutting off with the lever the regulating valves were left in adjustment for starting the fire again provided it was right before. The new fire is started by a torch inserted into the plug hole around the burner.

On the second run the strainers and regulating device for the heater tank had been completed. The oil apparatus was handled with greater ease and uniformity, and the less amount of smoke was very noticeable. For intervals of an hour or more scarcely any or none would be observed. On the run in from the Farallones the engine was speeded up to 74 to 77 turns, and an average speed of 14¼ knots was obtained. The steam pressure was uniformly maintained at the point desired without difficulty, and the oil-burning apparatus gave no trouble whatever and worked well.

The oil used on both runs was from the Kern River district, near Bakersfield, Cal.

The following data was observed:

Steam pressure	pounds	160-170
Revolutions of engine		74- 77
Revolutions of air compressor		60
Pressure of air	pounds	20
Temperature of oil entering heater	degrees F.	80
Temperature of oil leaving heater	degrees F.	120-130
Temperature at base of stack	do	750

It is regretted that the nature of the trials did not permit of obtaining a greater amount of data beyond observing the apparatus in use.

The chemist at the New York yard submitted the following report upon the sample of the Kern River district oil sent him for analysis:

The sample is practically free from low boiling naphtha, as on distillation only a small percentage passed over below 150 deg. C., and less than 10 per cent below 225 deg. C. A boiling point above 360 deg. C. was reached before the second 10 per cent was collected.

It shows on ultimate analysis the following composition:

	Per cent.
Carbon	84.43
Hydrogen	10.99
Nitrogen	0.65
Sulphur	0.59
Oxygen	3.34

This gives a calorific value, by Dulong's formula, of 18,806 B. T. U. The specific gravity at 60 deg. F.

is 0.962. Flash point, 228 deg. F. Fire point, 258 deg. F. Vaporization point, 178 deg. F. Loss for six hours at 212 deg. F., 12.01 per cent.

REPORT OF LIEUT. WARD WINCHELL ON THE VOYAGE OF THE "MARIPOSA."

U. S. S. "Boston,"
At Sea, August 15, 1902.

Sir: In accordance with the Department's telegraphic order of July 7, 1902, delivered July 8, 1902, and the instructions from the Bureau of Steam Engineering, dated July 7, delivered a few minutes before sailing, I took passage on the Oceanic Steamship Company's steamer "Mariposa," leaving San Francisco at 10 a. m. July 15, 1902, for the round trip to Tahiti.

In accordance with the instructions of the Bureau, I took two sets of indicator cards each day, making 15 sets in all, the data of which were worked up.

There have been no tests to determine the evaporative efficiency of the two main double-ended boilers used on the run, and I regret to report that the chief engineer of the ship was unable to improvise any apparatus by which the amount of feed water could be determined with accuracy enough to give data of any value.

The amount of oil is a matter of much importance, since the tanks hold barely enough to make the round trip and but one day's supply of coal is aboard. The oil was measured first by the amount pumped into the two settling tanks, as shown in inches on the scale back of the gage glasses on the tanks; second, this amount was checked by the number of inches used out of each tank for each watch; third, another check, and the one considered the most accurate as dealing with large quantities and small errors, was by sounding the tanks from time to time and comparing the amounts taken out with the expenditures in the log. The latter method gave a correction which was applied to the daily log, increasing the daily expenditure slightly, as summed up by inches in the settling tank.

The most careful inspection at Tahiti failed to show any bad effect of the flame upon the boilers. No leaks nor defects developed anywhere about them and there was no difficulty at any time in feeding them. As I was ordered to the "Boston" immediately on my arrival at San Francisco, I lost the opportunity of again inspecting the boilers, but no defects showed from the outside. At Tahiti the tubes were swept by tube scrapers, and back connections, uptakes, ash pans and furnaces were cleaned. All the refuse from these various places barely filled two ash buckets.

This refuse, mainly soot, was the result not only of the twelve days' run to Tahiti, but also of the three preliminary trials by the contractors. The first one, a four-hour trial of engines and boilers, was made with Comax coal, and the other two were free runs at sea, of about eight hours' duration each, burning oil. The tubes had never been cleaned previous to arrival at Tahiti. It is the intention hereafter to make the round trip of twenty-four days' steaming without sweeping tubes.

There are no precautions other than those usually taken on board ship to guard against fire or explosion. All spaces to which oil has access are well ventilated by both inlet and outlet ducts. The oil is a thick, dark fluid, like molasses, and in the open air burns slowly, giving off much smoke. But it gives off volatile gases which form explosive mixtures with air, tanks empty or nearly so being more dangerous than full ones in this respect. The ship is electrically lighted, but in addition an open hand lamp is burning in the fire room all the time to light the burners; the firemen smoke on watch, and the oil is treated no more tenderly than if it were coal. On the run back, the cargo of copra was stored all about the expansion trunk, which projects up 4½ feet between decks, completely covering the tanks and making them inaccessible for examination.

Of the 6 firemen, 3 were relieved from watch the second day out, leaving but one man on a watch to fire 12 furnaces in two different fire rooms separated by the length of the double-ended boilers. The water tender did not touch the burners except in emergency, his duty being to 'tend water, fill settling tanks and record height of oil in them, record temperatures of oil at settling tank and in heater of fire room and of superheated air, take reading of lower pyrometer where the two uptakes meet, and run oil pump supplying oil to the settling tanks and small oil pump supplying oil to the oil heater.

As a coal burner the "Mariposa" formerly had the following engineer force: 1 chief engineer, 3 assistant engineers, 3 oilers, 12 firemen, 12 coal passers, 3 water tenders, 1 messenger, 1 storekeeper; total, 36.

A reduction of 16 men in the fire-room force is effected by oil burning. At sea she needs now but 3 firemen, but carried 6. This would reduce the force by 19 men.

Temperatures of fire rooms seem to be about what one would expect in coal burning, but the temperature of the uptake and smoke-pipe gases run high, the maximum being 925, which shows an undue loss of heat here. The temperature of the oil in the settling tanks ranged between 68 deg. and 100 deg. F. on the trip out and between 90 deg. and 108 deg. F. on the trip back.

The oil auxiliaries comprise 1 large oil pump, 2 small oil pumps, 2 oil heaters, 1 air compressor, and 4 strainers.

There is a steam-pipe connection to blow out the oil strainers, and another one to blow out the oil burners when clogged.

On August 3 the air compressor needed overhauling, and steam atomizing was kept up for two and one-half hours until the compressor was again working. During this time the evaporator supplied enough feed water to use 20 burners; the engines were not stopped while shifting from steam to air atomizing, and averaged 67.8 turns for the two and one-half hours. They had before been making 70 turns. Also during the four days in port at Tahiti the forward main single-end 3-furnace boiler was used, atomizing with steam. Generally 2 burners in the middle furnace gave ample steam to run the following auxiliaries, all exhausting into the atmosphere, the boiler being fed with fresh water from the dock: Ice machine, dynamo, flushing pump, feed injector, 2 cargo winches, small portable steam pump, and steam for cooking, bath tubs, etc.

At first two firemen and a water tender were on watch at a time, each fireman having 1 fire room of 6 furnaces or 12 burners. The men had but little experience, combustion was poor, much smoke was made, much oil burned, and poor speed attained. To locate the responsibility for bad adjustment of burner valves, but one fireman was put on at a time to attend 12 furnaces (24 burners). This made an improvement in the combustion.

Unfortunately, the top of the funnel cannot be seen from either fire room, and while the fireman can tell by the appearance of the flame as shown in the sight-hole, or even by the roar of the burner, when the combustion is perfect, in designing a boiler room for liquid fuel the ventilators should be so arranged that a view of the top of the smoke-pipe can be had from each fire room.

The work of the fireman would be even easier than it is and better results attained if the oil and air pressure is kept constant and the heated temperature of the oil constant. The apparatus then, once properly adjusted, would need very little change. To get these results is a mere matter of detail easily arranged. If the temperature of the oil rises it feeds more freely and a readjustment is necessary, and the same conditions hold with regard to the pressure.

It will be noticed that in addition to the independent oil and air supply valves the burners are fitted with an air plug cock and an oil plug cock connected to one lever, which then controls both air and oil supply, enabling the operator to shut them both off at once in emergency. At first when steam went up too high and a burner was shut down this lever was used; but shutting off the air thus gave the air compressor less work, and as its governor is not sensitive the air pressure increased, making a readjustment of all oil and air supply valves necessary, with consequent smoke. Later on, when it was desired to shut down a burner, the oil alone was shut off by the independent feed valve on the burner, and the untouched air valve kept the air compressor's work more nearly constant; then when the burner was again required, the oil valve was opened and immediately lighted from the flame of the adjacent burner.

In starting fires with everything cold, steam is raised on the auxiliary boiler, which burns coal, and the air compressor, oil pumps, and oil heater are started. The oil is lighted by inserting oil-soaked rags in the air space surrounding the burner and touching a lamp to them, or an arrangement like a gas lighter may be used.

Sometimes when the air pressure is too high, or insufficient oil is feeding, the flame flickers and may go out. If the oil is kept feeding under these conditions, on relighting there is a small explosion of the gases in the furnace, with a momentary back draft through the peep-holes and ash pans.

When shut down July 19, for two and one-half hours, plugging condenser tubes, one burner at each end of each boiler (4 burners in all) furnished steam to run all auxiliaries, including feed pump, bilge pump, air compressor, ice machine, dynamo, and flushing pump, all of which were exhausting into the atmosphere.

During the four days in port at Tahiti the forward main single-end 3-furnace boiler was used, atomizing with steam. Generally two burners in the middle furnace gave ample steam to run the following auxiliaries, all exhausting into the atmosphere, with boiler fed from fresh water on the dock: Ice machine, dynamo, flushing pump, feed injector, two cargo winches, and small portable steam pump.

In the Grundell-Tucker burner the oil, heated by a steam coil under boiler pressure throttled down, passes through the inside pipe and is thrown out radially through the series of small holes. The air, first heated by compression up to 20 pounds, is further heated to a temperature of about 350 deg. F. in the air chamber surrounding the burner, and called the air superheater. Air can be used at the temperature at which it leaves the compressor, and was so used on the trip down until July 17, when the superheaters were connected up. This air under the pressure of about 20 pounds surrounds the oil pipe in the burner and passes axially along the pipe until near the end, where it is given a whirling motion through small helical passages arranged like the rifling of a gun. It crosses axially and whirling through the fine oil streams spurting radially from the end of the burner, breaking up the oil into fine spray, the drops of which can be seen before they ignite. A further air supply (cold) is admitted through the hinged door of the ash pan, and is directed up across the path of the flame and heated also by a curved fire-brick wall built in the ash pan close to the front.

This ash-pan door is not moved much, but the regulation of the air supply is by the valve control of the air and oil in the burner. The flame should be a steady, full, white or yellowish white one, filling the furnace.

The principal difficulties encountered were in the regulation of the supply of oil to the heaters by the pump and the consequent variation of the temperature of the heated oil and the freedom of flow through the burners. An automatic submerged float, arranged like a steam trap and fitted in the oil heater to control the throttle of the pump, failed to give good automatic results, and the supply of oil was regulated by hand. If the oil is heated too much (above 150 deg. F.) some of the volatile gases are given off and mingle with the air pressing on top of the oil in the heater, thence passing with the air into the air superheaters and burners, the result being that on one occasion a heater got red hot from this cause.

Another difficulty was due to the choking of the strainers by foreign matter and impurities in the oil, shutting off the supply of oil, and on one occasion, August 10, putting out all the fires. Just previous to the fires going out, and while the usual air supply was on, and an insufficient amount of oil being fed, a dense white smoke like steam arose from the funnel.

This strainer difficulty will be solved by fitting the strainers in pairs, so that a clean one can always be switched in while the choked one is being cleaned.

Generally the revolutions of the engines did not vary much during the day, and in calculating the horsepower for each day's average revolutions, when the cards for that day differed much, that set was selected whose revolutions were near the average for the day with the indicated horsepower, assumed to vary as the cube of the revolutions. If the two sets of cards for the day had the same number of revolutions their average indicated horsepower was used as a basis to compute the day's horsepower as before.

It will be noted that the log accompanying this report is kept from noon to noon. This was done as the patent log was inaccurate, and the speed of the ship was got from noon positions as given by sights.

It will be noted that speed was much higher on the return trip than on the outgoing, which is ascribed partly to the better combustion as the firemen got experience, partly to the overhauling of the bearings at Tahiti by the force on board, and mostly to the increased oil consumption allowed after the run down had proved there was plenty of oil for the return trip, which was a matter of some doubt before, the ship being provided with coal for twenty-four hours to cover possible emergency.

Full power was not developed in the two boilers used, as schedule time was easily exceeded with from 2 to 4 burners shut off, though it would not appear, from the tabulated results that the indicated horsepower would equal what can be got by a good system of forced draft. This burner, however, works well with the Howden system of forced draft, as seen on the tank steamer "George Loomis."

It must be remembered that the tabulated calculations are all based on the indicated horsepower of the main engines only, as it was considered better to use only data actually obtained, and afterward estimated data, such as indicated horsepower of auxiliaries, could be applied without vitiating the observed data and results. No cards could be taken from any of the auxiliaries, but careful estimates give the following results:

	I. H. P.
Air compressor, at 60 revolutions per minute	110
Auxiliary feed pump and two oil pumps, one in intermittent use	30
Dynamos	30
Ice machine	7
Circulating pump	5
Flushing pump	2
Baths, steam tables, evaporator, cooking, etc	11
Total	195

The steering engine is not used except near port.

The size of air compressor was based on the assumption that it requires 1 cubic foot of free air for every pound of water evaporated from and at 212 deg. F., as shown by tests of various oil burners at Western Sugar Refinery, San Francisco.

The weights of oil auxiliaries are as follows:

	Tons.
Air compressor	9
Two settling tanks	12
Two oil heaters	2
Two oil pumps (small)	0.5
One oil pump (large)	1.25
Fifteen superheaters (air) front	3.1
All pipe, valves, fittings, ventilators, etc.	8

It should be remembered that the boilers were designed for coal burning; that the oil-burning plant was fitted up in a hurry, the machinists not leaving the ship until the gong rang for people to go ashore; that the firemen were without experience in oil burning, and that most of the automatic gear did not function properly.

With the air pressure constant; with the oil heated at constant temperature near 140 deg. F.; with oil strainers arranged in pairs, so that one is always efficient, and with experience in firing, the results in economy of oil should be much better on the next trip; and the fireman's work, already very easy, will approach supervising automatic regulation. The fireman does not need strength nor previous training with coal. He should have a good eye, good ear, some common sense, and a desire to learn a new and easy trade.

In conclusion, I wish to state that every facility was given me by all the officers of the company, the chief engineer of the ship being particularly zealous in arranging for the taking of required data.

Very respectfully,
WARD WINCHELL,
Lieutenant, United States Navy.
Chief of Bureau of Steam Engineering,
Navy Department, Washington, D. C.

PLANTS ON AN IRISH BOG.

To KNOWLEDGE, Mr. R. Lloyd Praeger contributes an article which deals with bog vegetation, in the course of which he writes: "The oozy sinuous pools are filled with Sphagnum, and here and there with the Bog-bean, Menyanthes trifoliata; the edges of the pools are luxuriously cushioned with a variegated growth of Sphagnum, and these edges are the favorite haunt of two of those wonderful fly-devouring Sundews, Drosera rotundifolia and D. anglica. In the shallower pools, or on the bare mud, the White Beak-rush Rhynchospora alba, grows in tufts, and its farther-creeping relative, R. fusca, fills portions of the pools with an erect growth of bright green stems and brown inflorescence. The conditions under which this plant-group lives are remarkable. The spongy crust is perennially saturated with water, which circulates very slowly. In consequence the soil is badly aerated, and the plant-remains which form the crust do not become thoroughly oxidized, and soluble humus compounds remain in solution in the water. The plants can with difficulty absorb by their roots water charged with these substances, and thus it comes to pass that while the bog is physically very wet, physiologically it is very dry. In the midst of plenty the plants are actually starving. Exactly the same difficulty, it may be remarked, occurs in salt marshes, where the water is charged with sodium chloride. In both cases the plants meet it in the same way, by checking trans-

piration, and thus saving up the water which they absorb. Thus they assume characters similar to those displayed by plants of deserts and dry places—xerophytic characters, to return to a term which we have had occasion to use before. These are seen in the smallness of the leaves of the heaths, for example, as well as in the curious backward-rolled character of their leaves, as well as of those of the cranberry, crowberry, etc. In other cases the leaves are protected by a thick impervious cuticle or skin, or by a close growth of hairs. Another peculiarity in the conditions under which the bog flora grows is that in the water-logged soil there are no bacteria present, which are so useful in breaking up the complicated nitrogenous compounds contained in the dead plant matter; hence nitrogen as a plant food is scarce. This may help to explain why the Sundews, which are essentially bog-plants, have hit upon the extraordinary manner of obtaining nitrogenous food for which they are famous—the capturing, killing, and digesting of small animals."

ELECTRICALLY-OPERATED CANALS IN BELGIAN COAL-MINING DISTRICTS.

IT would not be surprising if, within a few years, the principal canals in this country, as well as those abroad, were electrically operated, as this method of propulsion is not only very convenient and economical, but also may be made to greatly increase the traffic, on account of the increased speed thus made possible.

The development of electric haulage on canals is slow, but some interesting experiments have been made in this line in Europe; one of the most successful, although working under great disadvantages, is that on the Charleroi Canal in Belgium. This electrically-operated canal serves the Charleroi coal mining region in Belgium with more or less success. The conditions limit the speed and economy, but these could be greatly improved on with an entirely new and modern equipment and a deep and well-constructed waterway.

The experiments on the Erie Canal in New York State, while not in every way successful, demonstrated the fact that electric propulsion is not only possible in this country, but, with plenty of water power at various points on the line, might be made very efficient, as compared with the present methods with horse, mule, or even steam canal-boats. The new power house at Niagara Falls on the American side is nearly completed, and will add 50,000 horse power more to the present development of the Niagara Falls Power Company, making a hundred thousand horse power for transmission and distribution, with a possible 100,000 horse power more from the same tunnel as a tail race. Another 100,000 horse power is available from the power canal passing through the city of Niagara Falls on the surface, while the Canadian Power Company has already let contracts for a number of 10,000 horse power turbines and generators, and when completed this plant will add 200,000 horse power more. It will thus be seen that practically half a million horse power is already in sight for electrical power transmission in and about Niagara Falls, Western New York and Canada. It will, therefore, be surprising if the Erie Canal, as well as the Welland Canal in Canada, are not looked to in the near future as users of this power; and electrical canal haulage will without doubt increase the traffic of ore and coal from the mining regions about the Great Lakes.

The coal mining regions of Belgium, in the Charleroi district, are connected with Brussels and Antwerp by the Charleroi electrical canal, which is a narrow waterway about 50 miles long. There are two central power stations, one at Oisquercq, 15 miles south of Brussels, and another at Roux, 6 miles north of Charleroi. These stations are 29 miles apart, and the former is equipped with three 125 horse power Corliss engines, each driving a polyphase alternator constructed by Brown, Boveri & Co., of Baden, Switzerland. These machines supply an alternating current of 15 amperes each, at a potential of 6,000 volts.

The power station at Roux is of larger capacity, the engines and generator sets having a capacity of 325 horse power each, as they supply current for lighting and industrial purposes, as well as for operating the canal apparatus at various points along the line.

There are sub-stations located at points along the canal about three miles apart. Each of these contains a step-down transformer, which lowers the pressure from that on the transmission line, or 6,000 volts, to that used on the trolley line, or 600 volts.

This electrical haulage system was designed and constructed under the direction of Léon Gerand, the consulting engineer of the Compagnie Générale de Traction Electrique sur les Voies Navigables, to whom the writer is indebted for the information regarding this electrically-operated canal.

FIG. 1.—CORE OF AN INDUCTION COIL.

The "tracteurs," or electric automobiles, one of which is seen in detail herewith, are used to draw canal boats in the same manner as horses or mules, and each has a capacity of about five horse power. They work over sections of various lengths, and when they meet another going in the opposite direction they do not pass each other, but exchange tow lines and return with the boat they meet; the outfit not being turned around, but the operator simply changing his seat and facing in the opposite direction, the controller still being within easy reach, as seen in the accompanying drawing.

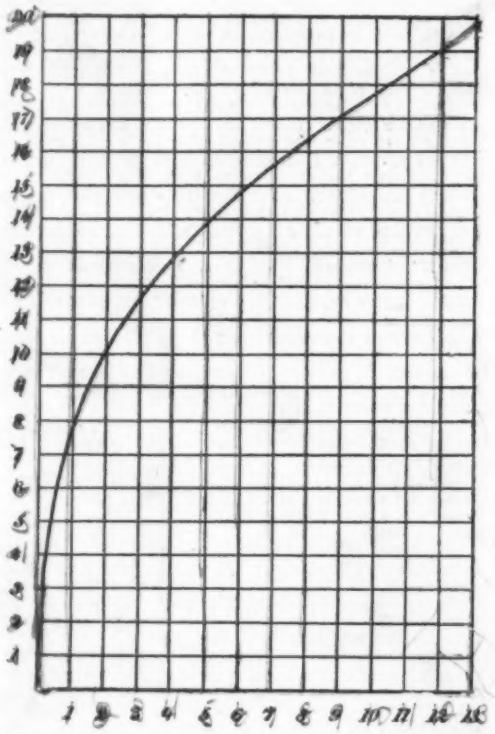
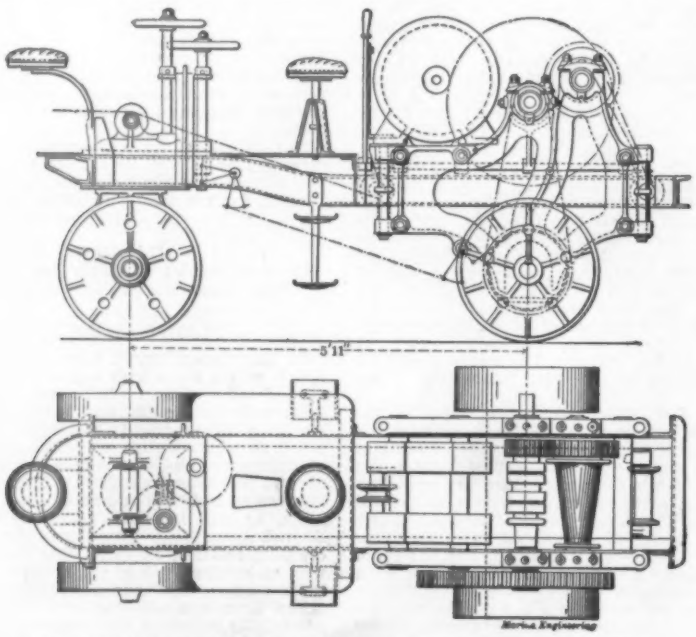


FIG. 2.—RELATION OF CORE TO SPARK. ABSCISSAS INDICATE LENGTH OF SPARK IN INCHES. ORDINATES INDICATE LENGTH OF CORE IN INCHES.



ELECTRICALLY OPERATED CANALS IN BELGIUM.

The banks of the canal are so narrow and in such poor condition for much of the way that electrically-operated tugboats are also employed, which generally have a speed of 8 miles per hour. An insulated cable conveys the current to the boat from a three-phase trolley line, this cable being supported from a pole attached to a mast on the boat, and trolley device of peculiar construction, which seems to operate at speeds of 6 and 8 miles per hour without trouble, although a speed of only 2 miles per hour is used in towing two 70-ton boats. The mast is about 14 feet above the water, and the boat can travel at a distance of 50 feet or more from the line and is free to turn around and maneuver similarly to a steam tugboat. The boats have a capacity of 70 tons, with a draft of only three feet, and are greatly hampered by the depth of water, which is only about 3½ feet. On account of the narrow path, and heavy and irregular loads due to this small depth of water, with considerable mud on the bottom, the speed is low and the amount of energy required is comparatively large, the necessary current being about 6.5 kilowatt hours per boat mile, although this has been lowered to 5.5 per boat mile, while the mean traction pull is 360 pounds, and the maximum 1,320 pounds.

It was of considerable importance to more efficiently connect Brussels with the Charleroi coal district, and the electrical haulage has done this satisfactorily, considering the condition of the canal, increasing the speed of towing from 1¼ miles per hour, which was the rate of speed with horses, to 2½ or 3 miles per hour with the electric system, and with no additional cost per mile for an equal tonnage, which averages about 25 cents per boat per mile. The total traffic per year amounts to more than half a million tons.

The motor car, or tracteur, is equipped with a winch, which may be electrically operated from the motor axle, which the operator can disconnect from the wheels; and by this electrically-operated winch a stranded boat may be relieved, and a boat may be forced out of a lock. With the electrical method of haulage the passage of a lock may be made in less than five minutes, while it took three times as long for the passage of a lock previously with horses on the Charleroi Canal.

The Mons district is connected to the sea only through French territory, but the Liege district is connected by both river and canal over a trifle more than 100 miles, and Brussels is about 30 miles from Antwerp along the canal.

Considerable has also been done with electric propulsion of canal boats both in Germany and in France, on the Finow, Aire, and Deule canals, the latter between Bethune and Douai.—Marine Engineering.

THE CORE OF AN INDUCTION COIL.*

By WILLIAM A. DEL MAR, A.C.G.I.

THE efficiency of an induction coil depends very largely on the care exercised in the design and manufacture of the iron core. The iron must be of high permeability and must have little retentivity. A straight core is always used for the following reasons. When the current is reduced from its maximum value to zero by breaking the battery circuit, the magnetic flux falls from its maximum value, not to zero, but to a value known as the residual magnetism. Now the residual magnetism in an open magnetic circuit is much less than in a closed circuit, so that when the current is suddenly reduced to zero, the magnetism drops lower in an open circuit than in a closed one. As the electromotive force in the secondary is proportional to the amount of magnetism destroyed, it is greater with a straight core than with a completed circuit of iron.

The length of the iron core is determined by the following considerations. If it is made very long, the primary magnetizing current will be too great, while if made very short, the secondary coils would have to be made of too great a diameter to be efficient. There is hence a certain length which will give the best results. Mathematics, so useful in the design of closed circuit transformers, here fails us on account of its complexity, and the coil designer is practically obliged to determine the length of the core from the experience of others. The curve in Fig. 2 gives the length of core for coils of various spark length. The diameters of the cores are given in the table.

The iron core is made in the following way: Pieces of No. 18 or 20 A. W. G. iron wire are cut to the required length and put into an iron pipe the ends and superfluous space of which are filled with clay or plaster. The pipe is then left in a coke or coal fire until the fire has gone out naturally, in order to assure slow cooling. When cold the wires are taken out and sandpapered to remove superfluous oxide. They are then, one by one, dipped in boiling water, wiped dry, and coated with thin shellac varnish while still warm. When the varnish is dry they are bound tightly into a bundle with thin wire wound on paper as shown in Fig. 1. One end of the bundle is filed flat and smooth and the other end left rough. The ends of the binding wire are fastened by means of a small amount of solder. The use of the insulating varnish is to arrest eddy currents and thus prevent the iron being heated and energy wasted.

The figures given in the following table are taken from coils of various makes, and with judicious design could be considerably improved upon. They are merely intended as a rough guide to coil makers:

TABLE OF INDUCTION COILS.

Length of Spark (Ins.)	Length of Core.	Diameter of Core.	Prim'y Wire No. A.W.G.	No. Layers in Primary.	Sec'd'y Wire No. A.W.G.	Secondary Wire, Wgt. in Lbs.	Condenser. No. of Sheets.	Condenser. Area of Sheets.	Voltage of Battery.
⅛	3	½	28	2	36	⅛	25	2 x 1	2
¼	3½	⅝	28	2	36	¼	40	2 x 1½	2
⅜	4½	⅝	28	2	36	¼	45	4 x 2	4
½	6	¾	28	2	36	¼	50	2 x 3	4
¾	7	¾	26	2	36	¾	60	4 x 4	4
1	8	1	26	2	36	1	100	7 x 5	12
2	10	1¼	24	2	36	2	200	7 x 7	12
3	11¾	1¼	24	2	36	3	150	9 x 7	12
4	14¾	1½	24	2	36	10	900	9 x 9	16
12	19	1¾	20	3	36	12	60	12 x 8	10

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

TURBINE INTERRUPTER FOR ELECTRIC CURRENTS.

AFTER finding that interrupters with metallic contacts were incapable of actuating large induction coils, Foucault devised the mercury interrupter that bears his name. An endeavor is now making to utilize currents of a higher difference of potential, such as those furnished by the electric sectors of Paris, for which the Foucault interrupter is itself inadequate. It has therefore become necessary to return to interrupters with contacts of metal upon metal. But many of these apparatus are defective in that they become heated, and are irregular and incapable of operating for a sufficient length of time.

After many experiments, MM. Lecarme and Michel have succeeded in constructing an interrupter that gives satisfaction in every respect and the operation of which approaches perfection (Fig. 1).

This apparatus is arranged like a centrifugal turbine, with the difference that the paddles are provided with flexible metal prolongations, *p p'* (Fig. 2), so that, during the revolution, those of the movable part, *p*, come into contact with the stationary one, *p'*. Through this arrangement the prolongations that are revolving strike with force those that are at rest, and during the period of each contact, the pressure of the stationary contacts upon the movable ones increases until it becomes maximum at the moment of the breaking of the current. The result is that the intensity of the latter increases during the entire duration of the contact, and then becomes abruptly null. At this moment, the insulating liquid, carried along by the revolution of the system, as in a centrifugal pump, blows out the spark and at the same time cools the contacts. This motion of the liquid, which is continuously renewed toward the edge of the arms, keeps the contacts in a perfect state of cleanliness and thus prevents their oxidation.

The arrangement indicated in Fig. 2 comprises: (1) A stationary part formed of a metal cylinder, *a*, that carries upon its internal surface a certain number of contacts, *c*, *c*, and that is filled with an insulating liquid; (2) a movable part formed of an axis, *b* arranged in a line with the cylinder and carrying a piece of bronze, *t*. This piece, which is in the form of a turbine, is provided with as many arms as the cylinder is furnished with stationary contacts (four in the figure). When a rotary motion is given to the axis, *b*, all the movable contacts, *p p*, come simultaneously opposite the stationary ones, *p' p'*.

The cylinder, *a*, and the axis, *b* (perfectly insulated from each other), are interposed in the circuit of the current to be interrupted; and the current is established every time the movable contacts touch the stationary ones.

It will be seen from this arrangement that it is possible to cause the passage of a current of very great intensity by multiplying the number of the arms and increasing their length and, consequently, their surface of contact. The breakage spark is thus dispersed and equally distributed at the rate, say, of 1 ampere per 4-10 inch of length of contact. All heating is therefore prevented.

On another hand, when the rotary velocity becomes very great, and gives rise to very frequent interruptions, instead of the mean intensity of the current diminishing as in other interrupters, the centrifugal force tends to throw the movable contacts outwardly, and consequently to increase their pressure upon the stationary ones. The intensity then remains sensibly constant, whatever be the velocity. Thus, a large coil, actuated by this interrupter and a current of 110 volts, gives a jet of sparks between the terminals for 10 interruptions per second, as well as for 200. It must be noted, however, that if a constant capacity be preserved in the condenser of the coil, the intensity of the current will vary slightly with the velocity. With variable condensers it is possible to keep it perfectly constant.

The following are the results obtained, after numerous experiments, with an apparatus of four arms 2 inches in length. The current furnished by a dynamo of 120 volts traversing a coil giving a 3-foot spark was of a mean intensity of 20 amperes. After an hour's operation the temperature was 35 degrees. The same apparatus has even been operated with a current of 40 amperes, without any appreciable wear being exhibited by the contacts. A large apparatus of Tesla's, actuated by the same coil, gave rise to a multitude of discharge sparks that made so loud a noise that it was impossible for a person to hear his own voice, even at the other end of the laboratory, or to perceive the noise of the machines. We think that these experiments permit of the hope that wireless telegraphy may derive profit from this apparatus, and that, through the use thereof, it will be possible to increase the range of the signals to be transmitted.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

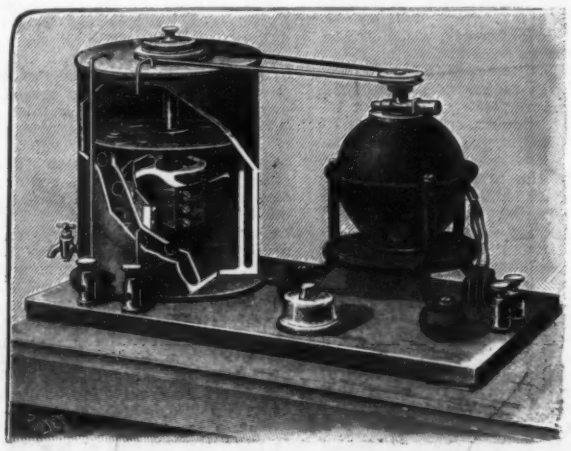


FIG. 1.—TURBINE INTERRUPTER (GENERAL VIEW).

MARCONI'S "CARLO ALBERTO" EXPERIMENTS.*

By EMILE GUARINI, Brussels, Belgium.

THE daily papers and technical journals all over the world have published the results of Marconi's recent experiments on board the ship "Carlo Alberto," results obtained at first during his voyage to Cronstadt and afterward in the Mediterranean, during which he communicated with the transmitting station at Cape Lizard over the extraordinary distance of 1,600 miles

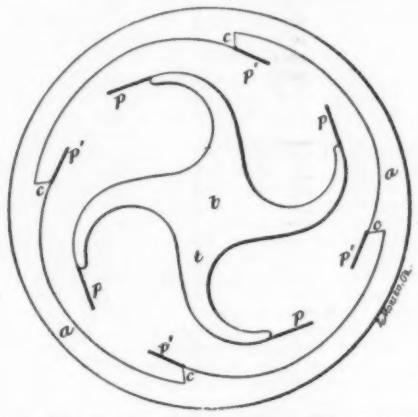


FIG. 2.—PLAN VIEW OF THE INTERRUPTER.

(French) of which a great portion was over dry land. There are many who are still incredulous, not so much because of the seeming impossibility of such a feat, but rather on account of the contradictory and exaggerated reports furnished by the papers, which at the same time attributed to Marconi conversations and plans in which the illustrious inventor perhaps never indulged. In this manner much was made of the *absolute secrecy* of the communications resulting from his new system of attuning the receivers; also of the possibility of sending messages across Switzerland and the Alps; one journal even maintained that Marconi could without difficulty transmit his messages overland without regard to distance. It may be noted in passing, that, theoretically considered, messages are possible from any given point to any desired point upon the earth's surface, and provided sufficient impulse can be given to the electric waves, it is indeed practicable to send them through the earth itself. Archimedes once said: "Give me a fulcrum and a lever long enough and I will lift the earth." The problem to solve in this particular is whether or not such communications are practical, that is, whether the extreme cost of operating stations producing such high electric energy would not exceed the commercial revenue.

Demonstration has proven that it requires 40 horse power to communicate easily, during the day, with a station 1,000 kilometers distant. To send, therefore, a message 20,000 kilometers (about half around the globe, the complete tour not being necessary) and admitting that the energy required varies as the square of the distance a force of $20^2 \times 40 = 16{,}000$ horse power would be needed. This entails a by no means insignificant plant. Would not a line of intermediate automatic stations be even more economical? In this latter case the energy would increase instead of diminishing with the distance. Doubtless the general public will be glad to receive positive and reliable information concerning Marconi's above mentioned experiments and we cannot do better than give here a résumé of the official report made to the Italian Naval Department by Marquis Solari, who besides being the lieutenant commander of the vessel and a co-worker with Marconi in these trials, is a distinguished officer of whose valor and capabilities we have had personal demonstration.

Last June the ship "Carlo Alberto" of the Royal Italian Navy returned to England equipped with one of Marconi's old-style radiotelegraphic outfits, which had already withstood several journeys by rail and been several times shipped and transshipped without any special care. On this account the installation and regulating of the apparatus consumed several days' time and required much patience and care. Being thus supplied, the "Carlo Alberto," as soon as she arrived in English waters, placed herself in radiotelegraphic communication with the station at the Lizard in Cornwall where Marconi himself was, and with his aid at once took the necessary steps to set up a more sensitive and perfect appliance. On the 26th of October, Marconi came aboard bringing with him instead of the usual coherer, a magnetic detector. A supplementary mast about 50 feet high was erected in the forward part of the ship. Between this and the ship's foremast was suspended the antennæ carrying four cables, the antennæ being inclined in such a manner as to form a certain angle, and reflect, so to speak, directly into the operator's hut on the deck.

The points of suspension of this combination of spreaders and cables were insulated by chains of porcelain, and the cable entrance to the operating room was through an ebonite tube of suitable length and diameter. Every possible precaution was taken to insure perfect grounding; cables were attached to several parts of the machines as well as to the keel of the ship. An extra powerful transmitting station would require an especial outfit of implements which would be very cumbersome not to say expensive; accordingly the "Carlo Alberto" was only fitted out as a receiving station for wireless messages. Two ordinary coherer receivers furnished with transformers attuned to the station at Cape Lizard and three magnetic detectors were installed. The coherers were as usual connected with the Morse receivers while the magnetic detectors actuated the telephones.

The station receiver on board the "Carlo Alberto" was the same with which Marconi, in February last accomplished such remarkable feats on the "Philadelphia."

The transmitting antennæ at the Lizard resembled those which Marconi had installed at Cape Breton. Four wooden masts about 220 feet high were erected at the corners of a quadrilateral whose sides measured about 190 feet. The tops of the masts were connected by heavy steel cables, from which hung 400 copper conductors, 100 on each side of the quadrilateral, and placed a trifle less than two feet apart. All these conductors are united into one cable at about 13 feet from the ground before they enter the operating room. This construction presents the appearance of an inverted pyramid. The potential with which the aerial conductors were charged during the transmission, was such that sparks of 0.30c. could be obtained between their summit and a conductor placed on the ground. This is an enormous potential if one takes into consideration the stupendous power necessary to charge them.

Marconi himself arranged for all the experiments, fixed the hours of work both by day and by night, and determined upon the signals to be sent; he then embarked at Dover on the "Carlo Alberto" on July 7. At a distance of 500 French miles from the Lizard, and of which six-tenths of the flight was over dry land, the experiments began. No sooner had the attuning been effected to a certain point than the telephones connected with the magnetic detector gave forth the first sounds to come from Cornwall. "Because of the imperfect attuning," said the Marquis, "the first sounds from the telephones were feeble and indistinct, and also because of the anti-electrical effects of the sun's rays or solar light." On the following day messages were received with fewer obstructions and the coherers actuated the Morse receivers sufficiently to obtain a register or copy of the messages. The sending of messages from Cape Lizard being now suspended for the day, the "Carlo Alberto" became a transmitting as well as a receiving station and as such entered into communication with the English Marconi telegraph stations at North Foreland, Trinton, etc., through the courtesy of which he sent several dispatches to different points in Europe, notably one to the Italian Minister of Marine at Rome. During the night of July 7, and owing to the more favorable influence of darkness, the "Carlo Alberto" received additional signals from the Lizard now 900 kilometers away, both on the coherer receiver and on the receiver connected with the magnetic detector. During a trial, at a distance of 1,000 kilometers from the Lizard, which was made at noon of July 9, the coherer failed to catch any of the signals while the magnetic detector caught the rhythmic sounds of several SS. The following night and during the nights of the 11th and 12th of July, at first dispatches and then signals were received by Marconi at Cronstadt across the Scandinavian peninsula. At Cronstadt the signals (SS) were indistinct, because, it is said, fresh water makes a poor grounder. On July 23, the "Carlo Alberto" steamed for Kiel, and just at this time the reception of the signals had been much improved, either by effecting a more perfect attuning of the instruments or by increasing to 50 the number of the conductors suspended from the receiving antennæ. Thanks to these artifices several SS were distinctly received from Cornwall. On the return voyage the facility of receiving was improved still more, but a series of inexplicable phenomena occurred, the most notable of which was the sudden and total cessation of all signals. At 1 o'clock, on July 23, the "Carlo Alberto" being then in the Baltic, received very distinctly several signals from Cape Lizard, over 2,000 kilometers away. At 2 o'clock atmospheric disturbances interfered with the working of the coherer to such a degree as to render it useless for the time being, while the precautionary measures which had been taken prevented any interference with the working of the magnetic detector. An incomprehensible phenomenon now took place. At first the receiving became somewhat imperfect and at length it became impossible to get any response whatever. In vain were made all possible attempts to ameliorate the conditions, all efforts at receiving and attuning; in vain were the antennæ of the "Carlo Alberto" placed parallel with those at Cape Lizard by causing the ship to take up the proper position. The failure of this last resort proved that even for Marconi the manner in which the electrical waves or impulses proceed is still

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

an enigma. Discouraged by failure after failure, and having about abandoned all further effort to open up the interrupted communications, all hands were astonished when suddenly the signals began to come in again, clear and distinct. An attempt has been made to explain this phenomenon by the difference in the velocity of the electric rays when traveling over the land or over the water. Like Marconi and Lieut. Solari, we too are loath to accept this explanation.

In the roads at Kiel on July 24 many dispatches were clearly received on the Morse. Previous care having been taken to guard against the danger, messages were successfully and satisfactorily received during the raging of a violent storm. Experiments were made with Castelli's carbon and mercury coherer, concerning which so much comment has appeared in the technical press of England, Germany and America. It would seem, however, that these experiments were not satisfying. For several days thereafter excellent and uninterrupted communication was enjoyed with the station at Cape Lizard as well as with the other Marconi stations on the eastern coast of England. August 2 saw the "Carlo Alberto" anchored in the harbor of Plymouth. The twenty days ensuing were occupied with the necessary preparations for the radiotelegraphic campaign then to be undertaken in the Mediterranean. For this purpose the receiving antennæ were somewhat modified, being composed of 50 conductors placed at an elevation of 50 meters (about 160 feet) above the bridge. Everything being in readiness, on the 25th of August Marconi boarded the "Carlo Alberto" at Mullion and set sail for Ferrol, Spain. Both during the voyage and while in the port of Ferrol messages were received without serious interruption. Ferrol was left on the 30th of same month for Cadiz. During the course of this voyage it was possible to ascertain that the maximum distance over which a communication could surely be made, by day, with the power then available, viz., 40 horse power, and the sensibility of the receiver the greatest possible (discounting the atmospheric-electric perturbations) was about 1,000 kilometers. On the night of the 30th and 31st of August the effect of the interposition of the Spanish mainland was observed. In spite of this, the receiving coherer continued to work well, and all the news received by the wireless system was communicated to the officers and crew, who were much delighted thereby. During the night of the 3rd and 4th of September, the "Carlo Alberto" entered the deepest inlet in the roads of Gibraltar, where, in spite of the 1,500 kilometers of distance and the obstructions offered by the most rugged of land formations, several dispatches were received from Poldhu (Cape Lizard), among others the one relating to the health of the Czarina.

At this point in the official report there is a vague passage, which does not say with positiveness whether certain dispatches originating in England were received at Cagliari or at Spezzia. The report continues: "The successive days of the 4th, 5th, and 6th of September saw a new triumph for the imposing invention of Marconi most certainly demonstrated, viz.; the fact that from the beginning to the end no obstacle interfered with the satisfactory working of his system of radiotelegraphy, while conducting experiments in a closed sea, a sea closed by such extensive mountain ranges as the Mediterranean, and that the radio-telegrams arrived from Poldhu constantly and surely at the receiver on board the "Carlo Alberto." As proof of this we have the Morse ribbons regularly signed by Rear Admiral Mirabello, who thus personally attests the truth of these experiments."

We give below the conclusions drawn from the experiments by Marquis Solari:

1. To begin with, there is no limit to the distance which may be covered by the electric waves on the surface of the globe, if the energy employed in the transmission is proportionate to the distance to be traversed.

2. Dry land interposing between a transmitting and a receiving station does not interrupt the communication.

3. Solar light diminishes the radius of action of the electric waves, and an increase of energy, for the transmission during the day, over that necessary for night work is therefore required; the obstructive influence of atmospheric electrical discharges also compels the use of less sensitive receivers, if they are not to be affected, and a corresponding increase in the energy of the transmitters.

4. The magnetic detector has by these experiments shown itself far superior to every coherer, because it needs no regulating; because of its absolute constancy in operation as well as for its practicability and the extreme sensitiveness of the system.

5. The Marconi Wireless Telegraphy has by virtue of these latter improvements entered upon the field of the grandest of the applied sciences, either commercially or for military purposes, without limit of distance.

Several objections thrust themselves upon the mind on reading these sweeping conclusions of Lieut. Solari, conclusions which, we fear, derive no small amount of enthusiasm, justifiable enthusiasm for that matter, from the part that the valiant officer himself took in the experiments. We are only too willing to heartily agree with all the above conclusions, although upon the item of distance we are inclined to the transmission by intermediate relay stations; moreover we feel that, the mere fact that a communication may have been held between two persons, one on the coast, the other 1,000 or 2,000 kilometers at sea, does not prove that a like communication would be possible with the same expenditure of energy, the same antennæ and the same apparatus over a distance of 500 kilometers on the land. To the support of this doubting we desire to bring but one of many arguments: If the sea has an acknowledged directing influence over the electric waves, how is it possible to affirm that one may hold wireless intercourse over land without regard to distance? The electric waves may follow the sea or traverse the contours of continents, but that does not say that the transmission of a signal is equally as easy and possible over similar distances between two stations situated in the interior as if they were upon the sea. Concerning the dis-electrification of the transmitting antennæ, said to be due to the sun's rays or solar light, it appears to us that this difficulty might be readily overcome by covering the transmitter with an opaque body. It has several times been upon our minds to remark that certain insulating materials as caoutchouc and the like which surround the antennæ produce a diminution in the effects due certainly to absorption. (Note the experiments on the Righi.) As for the *magnetic detector*, the most explicit description and explanation is to be desired. We voluntarily admit that this instrument is surer than the coherer, which is not a very difficult matter, but is it more sensitive also? Can one conceive how little energy is needed to actuate coherers, as sensitive as those of Blondel for example? That the commercial future of wireless telegraphy is assured is indisputable; it is also indisputable, we think, that wireless telegraphy itself is discussed.

THE GENESIS OF COAL.

THE popular view of the formation of coal may, perhaps, be summarized as follows: Certain plants or trees grow in morasses; they decay and sink; more plants grow on the first layer, and sink in their turn. The weighted-down residue decompose through the influence of microbes, with the generation of methane and carbonic acid; and when the decomposed mass is afterward exposed to high pressure, we find, according to the age of the deposit, peat, lignite, coal, or anthracite—graphite does not appear to have the same genesis as coal. Some weak points of the popular view are pretty apparent. If time and pressure be the main factors which decide the character of the coal, then we should find anthracite in the oldest geological formations, and peat in the most recent. But lignite occurs in the Devonian, and we know historically of the change of mine timber into lignite, while we have no examples of peat passing into coal. Further, anthracite forming the bottom layer should contain most ashes, and, so far as actual experiments can teach us, the very highest pressures of 20,000 atmospheres do not cause vegetable fiber to become coal.

Dr. J. F. Hoffmann, of Berlin, who discusses this question in the Zeitschrift für Angewandte Chemie, raises some other points. He would distinguish three periods in the formation of coal. First, a period of microbe activity, a fermentation, so to say, then a period of decay, and finally the carbonization period proper. The microbe period cannot have extended into the subsequent stages, for most coals are comparatively dry, so that microbes could not have had access, nor lived in them, and the aromatic compounds which coal contains are, moreover, poisonous for microbes. There is probably no uncombined carbon as such present in our coal, according to F. Muck. The chlorophyl of the green plant has the power, we believe, to split the carbon dioxide which the plant inhales through its pores, in the sunlight, into carbon and oxygen, and this nascent carbon combines with water to form carbo-hydrates which build up the plant. These carbo-hydrates are not decomposed in their turn, but they polymerize, and the albuminoids which are also formed likewise. High pressure, time, long-continued access of oxygen, fermentation, and decay do not yield us carbon and water as final products as long as we keep to ordinary temperatures.

The case is different—and this is Hoffmann's chief point, argued out in a novel way—when we presume that the temperatures have fluctuated considerably. Mere heat does not change wood into coal, though we can finally obtain a substance like anthracite when we gradually raise the temperature above 400 deg. Cent. Hoffmann draws attention to the spontaneous heating and ignition often observed in vegetable products, and he studies the problem thermo-chemically. When carbohydrates are subjected to dry distillation, they split into carbon and water, the more completely the lower the temperature is kept. The water reacts again on the carbon *in statu nascendi*, and there result unsaturated compounds, such as we meet in coal. This combination takes place with absorption of heat, and is comparatively quick, so that we need not assume periods of thousands of years for this second period. During the first stage heat is given off, and the temperature may rise to 670 deg. Cent. in the case of carbohydrates under decomposition. Albuminoids behave similarly. With them, in fact, spontaneous ignition is very common in a certain sense. While, for instance starch does not heat spontaneously, germinating grain becomes very hot in the presence of albuminoids.

We will not inquire into the mutual relations between plant life, microbe life, and albuminoid food for the germ and for the microbe, which problem Dr. Hoffmann leaves untouched; but we will pass to authenticated cases of spontaneous ignition. Hay is very apt to heat in warm, damp condition, and to burst into flames when air gains access. Bran is not so easily inflamed; but Hoffmann had to investigate a case which set him thinking. The organized remnants of plants, such as hay and bran, he says, continue to breathe, and when they find no free oxygen—the live plant inhales carbon dioxide, though—they feed on the intermolecular oxygen, as the yeast fungus does in alcoholic fermentation. Wet flax is notoriously dangerous, and so are oiled rags. A mill containing grain and flour was burned down in Berlin some years ago; the fire was ascribed to spontaneous combustion, and in some big lumps of smoldering grain which had been thrown into the river Hoffmann discovered layers resembling lignite, coal, and anthracite in their sequence. In all these cases moisture favors the combustion or the fungus growth starting it, because there is a breathing process. With coal this is not so, because there is no organized fire and no breathing—or no fungus growth, we prefer to say. Geologically, we have reason to believe that the formation of the coal-beds was followed by violent tectonic convulsions, during which heat and pressure may have co-acted. If we start with a deposit of peat, most of the water would be squeezed out during these convulsions; but enough would remain for chemical reactions. By spontaneous combustion some seam would become charred; the heat would be communicated to another seam and so on, so that coal-beds of considerable extent would be produced. But Hoffmann himself sees that we do not understand, on these lines, how it is that coal-beds consist of fairly uniform coal—coal, anyhow, not lignite—all through down to their extreme veins. We do not arrive at any final conclusion as to the genesis of coal, therefore, and the chief interest of Dr. Hoffmann's paper lies in the fact that he draws attention to the influence of spontaneous combustion. The standpoint which geologists maintain toward this "growth in place" theory was very well expressed by Mr. Aubrey Strahan, in a paper which he presented to the Geological Society last year.—Engineering.

STARS BY DAYLIGHT.

ARE the stars visible to ordinary sight in the daytime? asks Mr. E. Walter Maunder in Knowledge. There is a widespread tradition that they are; that if an observer placed himself at the bottom of any deep shaft—as of a mine, a well, or a factory chimney—which may shut off scattered light and reduce the area of sky illumination acting on the retina, he will be able to discern the brighter stars without difficulty. The tradition is one of a respectable antiquity, for Aristotle refers to persons seeing stars in daylight when looking out from caverns or subterranean reservoirs, and Pliny ascribes to deep wells a similar power of rendering visible the stars the light of which would otherwise be lost in the overpowering splendor of the solar rays. The tradition, well founded or not, has often been adopted for literary effect. It seems almost sacrilegious to hint that no star known to astronomers could have shone down unceasingly upon poor Stephen Blackpool during his seven days and nights of agony at the bottom of the Old Hell Shaft; that at best he could only have caught a glimpse of it for a few minutes in each twenty-four hours as it passed across the zenith. Dickens indeed does not absolutely say that Stephen watched the star by daylight; it is only a natural inference from his description. But is the tradition true? Of course everyone knows that Venus from time to time may be seen even at high noon; but then Venus at her brightest is many times over brighter than Sirius. Then, again, the assistance of a telescope enables the brighter stars to be discerned at midday; but the telescope not only directs the eye and greatly limits the area from which the skylight reaches the observer, but it enormously increases the brightness of the star relative to that sky illumination. The naked eye observation of true stars in full sunlight stands in quite a different category. Humboldt, who was much interested in the question, repeatedly tried the experiment in mines, both in Siberia and in America, and not only failed himself ever to detect a star, but never came across anyone who had succeeded. Much more recently an American astronomer set up a tube for the express purpose of seeing the Pleiades by daylight, also with no effect. It has been supposed that Flamsteed, the first Astronomer Royal, sank a well at Greenwich Observatory for the purpose of observing Gamma Draconis, the zenith star of Greenwich, in this manner. The existence of the well is undoubted though Sir George Airy, the late Astronomer Royal, was unable to find it, but Flamsteed marks it on more than one of his plans of the Observatory, and there is a drawing extant of the well itself, showing the spiral staircase that ran down it. But its purpose seems to have been, not to have furnished the means of observing the star with the naked eye, but to enable the observer to measure as accurately as possible the distance of the star from the true zenith at the moment of transit.

COTTON GROWING IN CUBA.

ACCORDING to the New York Tribune, the subject of cotton raising in Cuba has become of widespread interest here, and it has been generally recognized as of the greatest importance to the island in view of the present low price which is commanded by the two principal products of the island, namely, sugar and tobacco. The extremely small returns from these two products, which the Cubans had come to believe were the only things that could be grown on their fertile land, have caused them to seek other ways of gaining a livelihood, and one way has been found in cotton raising.

Now that this product has come under a careful study the people who are investigating its possibilities are astonished at the promise which is held forth. The Sea Island variety can be grown here better, and in almost double the quantity to the acre, than in any other place of which there is any record. It seems incredible, but, to begin with, it can be safely stated that on a farm of a caballeria (thirty-three and one-third acres) the sum of $3,021.65 clear profit can be made over and above all expenses. These figures are not theoretical, but have been proved by experiment. Sea Island cotton's minimum production in Cuba is 1,500 pounds of seed cotton to the acre, and the maximum is 2,000 pounds, and the latter is not at all infrequent. A caballeria, then, calculating at the minimum production, will produce 50,000 pounds of seed cotton. This seed cotton will give one-fourth of its weight in lint cotton, or 12,500 pounds. At the latest report from Liverpool this cotton brought 27 cents a pound, which would mean $3,375.

Out of the $3,375 for which the cotton can be sold in Liverpool the cost of production of the cotton must be deducted. The price of land and all will be included in this estimate. One caballeria will cost the small sum of $333. In the South one plow hand and one hoe hand are employed to cultivate forty acres. In Cuba one plow hand and two hoe hands will be needed. These people for six months will cost the farmer, including wages and rations, $300. The seed to plant the caballeria will cost $23.35. To pick the cotton will cost $30, and, estimating that the seed will pay for the ginning, which it will more than do, the total cost of cultivation, picking, etc., amounts to $353.35. Deduct this amount from the previous figures and there remains the net profit of $3,021.65.

The reason for this immense profit in Cuban cotton is that Cuba produces more cotton to the acre, and of a longer staple, than that produced in any other part of the world. Cuban cotton is a full three and a half inch staple and upward, and, according to good authority, no other country has produced a three-inch

staple, except in exceptional instances. The reasons for the greater production and excessive length of the staple are the length of the season and the humidity of the climate, which permit it to grow to full maturity.

The question has become one of national interest, and also international interest, because American capital is investing in cotton lands and investments are rapidly being made. The Cuban Congress has a bill before it, which will undoubtedly pass. This bill provides for the free admission through the Cuban custom houses of all cotton machinery and the encouragement of the industry in every possible way.

SELECTED FORMULÆ.

Production of Various Tints on Silver Bromide Paper.—For the production of a variety of tints on silver bromide paper "Appollo" recommends the following process:

The picture, which has been exposed at a distance of 0.5 meter for about 8 to 10 seconds, is developed in the customary manner and fixed in the acid fixing bath.

For the latter the author gives the following receipt in "Gut Licht:"

Distilled water	1000 c.cm.
Hyposulphite of soda	100 grammes
Sodium sulphite	20 grammes
Sulphuric acid	4 to 5 grammes

First dissolve the sodium sulphite, then add the sulphuric acid, and finally the hyposulphite and dissolve.

Blue tints are obtained by laying the picture in a bath composed as follows:

A	Uranium nitrate	2 grammes
	Water	200 c.cm.
B.	Red prussiate of potash	2 grammes
	Water	200 c.cm.
C.	Ammonia-iron-alum	10 grammes
	Water	100 c.cm.
	Pure hydrochloric acid	15 c.cm.
	Immediately before the toning, mix:	
	Solution A.	200 c.cm.
	Glacial acetic acid	20 c.cm.
	Solution B.	200 c.cm.
	Solution C.	30 to 40 c.cm.

Brown tints. Use the following solutions:

A.	Uranium nitrate	12 grammes
	Water	1000 c.cm.
B.	Red prussiate of potash	9 grammes
	Water	1000 c.cm.

And mix immediately before use:

Solution A.	100 c.cm.
Solution B.	100 c.cm.
Glacial acetic acid	10 c.cm.

Pictures toned in this bath are then laid into the following solution:

Water	1500 c.cm.
Pure hydrochloric acid	5 c.cm.
Citric acid	20 grammes

In these baths the pictures may remain until they have acquired a sepia shade or a dark red brown or reddish tone, as desired.

For a standing development with metol the following stock solutions are prepared:

A.	Sodium sulphite	10 grammes
	Metol	1 gramme
	Water	100 c.cm.
B.	Soda	10 grammes
	Water	100 c.cm.
	For use, mix:	
	Solution A.	50 c.cm.
	Solution B.	50 c.cm.
	Water	1000 c.cm.

In this quantity a dozen plates may be developed.

Sympathetic Inks.—I. Dissolve sugar of lead 1, uranium acetate 0.1 and bismuth citrate in distilled water 100 and carefully add, drop by drop, spirit of sal-ammoniac until the solution becomes clear. Mix same with a few drops of gum arabic or sugar. The writing is invisible, but turns brown-black as soon as it is exposed to the fumes of hydrogen sulphide; the letters are legible for a few minutes and fade light brown, but can be made to appear again, as before, by moistening with highly diluted nitric acid, and can be regenerated.

II. The same end can be reached by a trituration of a little gum arabic with diluted sulphuric acid. Writing with this liquid is invisible, but turns black upon heating, which is due to carbonization.

The following table contains a compilation of all the various substances constituting, in an aqueous solution, the so-called "sympathetic inks" and the agents which render the ink visible. The three first named substances are considered the best, because the ink disappears again when the color cools off.

For writing.	For bringing out the writing.
Cobalt chloride	Heat
Cobalt acetate and a little saltpeter	
Cobalt chloride and nickel chloride mixed	
Nitric acid	
Sulphuric acid	
Sodium chloride	
Saltpeter	
Copper sulphate and ammonium chloride	
Silver nitrate	Sunlight
Gold trichloride	
Ferric sulphate	Infusion of gallnuts or ferrocyanide of potassium.
Copper sulphate	Ferrocyanide of potassium
Lead vinegar	Hydrogen sulphide
Mercuric nitrate	
Starch water	Tincture of iodine or iodine vapors
Cobalt nitrate	Oxalic acid
Fowler's solution	Copper nitrate
Soda lye or sodium carbonate	Phenolphthalein

—Pharmaceutische Zeitung, Berlin.

Show Card Ink.—

Pure asphaltum	2 ounces
Venice turpentine	1 ounce
Lampblack	½ ounce
Spirit of turpentine	½ pint

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

The Shoe Trade at Vera Cruz.*—Ten years ago, it was impossible to buy anything here in the line of shoe leather, except that of native stock and manufacture, and ready-made shoes for Americans were not to be had at all. These conditions are all changed now.

United States shoes have, within a very short time, made a name for themselves, and were it not for the excessively high prices asked for them, they would surely drive all others out of the market. As it is, however, only the better classes can enjoy the luxury of our shoes, and the great mass of the people is debarred from this privilege. The prices asked for men's foot wear—say, for instance, for a shoe that can be bought at retail in the East for about $2.50 or $3 Mexican ($1.25 or $1.50 gold), costs from $4 to $6 Mexican ($2 to $3 gold) here; and how a man who earns only from $1.12 to $2.50 (56 cents to $1.25) per day is to buy shoes at these figures is a riddle still to be solved. The pay of laborers and mechanics is about the same in Mexico, dollar for dollar, as in the United States, but in the former instance it is silver, while in the latter it is gold.

The merchant has to pay gold for his stock, and has to pay freight, duties, commissions, and other expenses; and this, with the present high rate of exchange, perhaps obliges him to charge the above figures for his goods; nevertheless, it seems there is a chance for improvement in this direction. In a recent conversation, a prominent dealer assured me that he had paid for a certain class of goods, at the factory in the United States, $2.50 gold per pair, and showed me books verifying his statement; evidently, he was charged retail prices for his goods, for the same grade could have been bought at retail in the city of New York for $2.50.

In women's wear, the same conditions prevail; a shoe sold in the North at from $1.50 to $1.75 (75 to 87 cents), is sold here for $3 ($1.50), and there is nothing to be had in American goods under this price. These figures are almost prohibitive, and naturally our export trade is the loser. Notwithstanding all these drawbacks, there is a house in this city that does business to the amount of $30,000 yearly; and this is only one of several stores that handle American goods, not only for local consumption, but in supplying small country dealers near by. This amount could be vastly increased, were the prices more within the means of the people. Every effort to attain that end should be made by the manufacturer.

All styles and shapes are worn—lace, button, elastic gaiter, low-cut, tan, black, or white—the average size being No. 6 (Mexicans, as a rule, have small feet). The larger sizes—say, up to No. 9—are called for mainly by foreigners. All styles of toes will sell, but the pointed toe is still the most popular. The Latin American has a neat, slim foot, with comparatively high instep. Single soles are the rule and double soles the exception. Extension soles are not called for; in rare instances only one may see them, usually on Americans or Englishmen. The best selling shoe is of light weight, with finely stitched uppers, single sole, and flat heel, without any steel nails to clatter along the sidewalks and frequently cause a person to slip on the smooth flagging, that invariably has a pitch toward the center of the street. For the peon class, an old-style brogan would have an immense sale could it be placed within their reach.

The principal obstacle to a heavier business is the high import duty and the fluctuations in the value of silver; the duty on the cheapest shoes is the same as on the finest productions.†

What is needed at Vera Cruz is an American shoe house, well stocked at all times with an assortment as varied as the tastes of the people. Such a house would have all the local trade and also that of the interior towns, but it would have to be under American supervision or management.

The tendency of American exporters has been to dispose of their manufactures to the foreigner for cash f. o. b. at point of shipment. A better way is to do as other nations do, and that is to establish branch houses in foreign countries and push their goods themselves thereby becoming more intimately acquainted with the requirements of the people and not being dependent on foreigners to open up a market for them.

The shipper must exercise the greatest care in having his goods classified according to Mexican customhouse requirements, and special attention must be given to consular invoices, as failure to do this even in trivial cases may cause the importer much trouble and annoyance, and may perhaps result in extra duties or fines. Consular invoices must be made out in strict conformity with Mexican laws. For the proper development of this territory, I cannot too strongly recommend that special efforts should be made by our manufacturers to enable the native workers to wear shoes, instead of going about in sandals or barefooted.—Wm. W. Canada, Consul at Vera Cruz.

Imports of Cheese Cloth into Cuba.—Minister H. G. Squiers sends from Habana, September 16, 1902, translation of an executive decree relative to the requirements to be fulfilled by importers of cheese cloth, to secure the benefits of the law of July 29, 1902.‡ The decree reads:

Upon the recommendation of the Secretary of Agriculture, Industries, and Commerce, and in exercise of the authority given me by article 68 of the constitution, I have deemed it well to decree the following:

To punctually obey the provisions of the law enacted by the Congress and sanctioned by me on the 29th ultimo, by which the fabric known as "cheese cloth" is declared exempt from the payment of import duties at any of the custom-houses of the Republic, it will be understood that the importers of the said fabric are bound to show, within the period of sixty days and at the office of the collector at the custom-house through which the entry may have been made, that said fabric has in its entirety been used in the growing of tobacco. The presentation of a certificate, which the mayor of the municipal district in which the property is located where the said growing is done will issue gratis, will comply with this condition.

If this requirement is not complied with, the importer will pay, at the respective custom-house, the duties which he did not pay on the importation of fabric, consequently collectors of customs will order that the fabric be appraised in accordance with the provisions of the regulations and tariffs, showing the corresponding weight and paragraph, and that the proper bureau record the fact that the duties on same were not paid, by virtue of this decree.

If the requirement that use be proven, as by this decree provided, is not complied with, collectors can in this manner easily comply with what has last been ordered.

The contract, which under this decree importers must sign before the proper customs collector, will be forwarded to the customs division of the Treasury Department, and likewise the certificate of the mayor.

It is hereby ordered that the said division duly record the contracts, and that it cancel them on the receipt of the different certificates.—T. Estrada Palma, President.

Habana, August 30, 1902.

New Pepper from Africa.—Consul Thornwell Haynes reports from Rouen, September 16, 1902:

There has just been laid before the French Academy of Medicine the result of an analysis made by Dr. Barillé of a new pepper of African origin, recently imported from Kissi, on the Liberian frontier of Guinea. This product, which has already been given the name of Kissine pepper, grows abundantly in this region in a wild state. It is not akin to any known species, and, being very rich in piperine and volatile oil, can be used both as a spice and as a condiment. Its grains, generally very small, are characterized by a pedicle at their base. They give a reddish-brown powder, highly perfumed, and of a peculiar aromatic savor. French journals speak of this article as another interesting and valuable addition to the already long list of French colonial products.

Exhibit of Alcohol Appliances at Lima.—Consul C. V. Herdliska, of Callao, under date of August 22, 1902, says he has been officially advised by the executive committee of the International Exhibition of Industrial Appliances of Alcohol, to be held in Lima, that the Government of Peru has postponed the inauguration of the exhibition, which had been fixed for the 1st of November, 1902, until the 1st of January, 1903. The particulars of this exhibition were reported to the Department by Vice-Consul Joseph C. Cree, under date of April 16, 1902.*

Manifests for Mexican Ports.—Vice-Consul J. G. Pagés reports from Vera Cruz, October 7, 1902:

A recent Treasury decision of the Mexican government provides a fine for the failure of masters of vessels, carrying cargo from a foreign port to several ports in Mexico, to procure certified manifests for each port for which cargo is destined. It has been the custom of masters to secure one manifest only for the several ports of the Republic, and it has been necessary for the customs officials at the first port of entry to issue certified copies of such manifest for the other ports to be touched. It has now been decreed that when a manifest is brought to the first port of entry, the collector of customs may issue certified copies for the other ports, collecting for each copy $10 gold, or its equivalent at the existing rate of exchange at time of issue at the port of destination, and $5 Mexican currency (about $2 gold), in addition, for each copy, as a fine or failure to obtain separate certified manifests from the Mexican consul at the port of departure.

German Demand for Cast Spring-Steel Plate.—Mr J. J. Langer, consul at Solingen, October 1, 1902, writes:

On July 10, 1902, I transmitted a report concerning the demand for cast spring-steel plate by P. D. Rasspe Soehne, of this place. Thus far, no communications have been received from parties wishing to furnish the desired article. The same firm now submits samples, which I enclose, to show quality, rolling and hardness of material desired, as used in the manufacture of saws.

The samples are on file in the Bureau of Foreign Commerce, where they may be examined by parties interested.

Demand for Pumps in Johannesburg.—Consular Agent William D. Gordon writes from Johannesburg, September 17, 1902:

A considerable market exists here for a high-lift centrifugal pump, having a capacity of from 6,000 to 15,000 gallons per hour. The most common height required would be from 500 to 600 feet. They are usually provided with extension bed plates for direct driving by electric motors. Such machines are now being built in Sweden and Switzerland, and if any manufacturer in the United States makes a competitive machine, I can secure a good connection here for him.

*In response to inquiries by a Boston trade journal, to which advance copy has been sent.

†See Advance Sheets No. 1206; Consular Reports No. 259, for customs duties on shoes in Mexico.

‡Advance Sheets No. 1424 (August 21, 1902).

*See Advance Sheets No. 1346 (May 20); Consular Reports No. 262 (July, 1902).

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No. 1480. October 28.—Agricultural Implements in France.

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No. 1482. October 30.—*The Markets of Hungary—Machines for Extracting Essence from Lemon Peels—*American Coal and French Gypsum—*Demand for Pumps in Johannesburg—Duty on Salt in Haiti—Russian Meat for London.

No. 1483. October 31.—Exhibition at Johannesburg—Canadian Commerce in 1902—Nautical Congress in Syros—German Capital in Foreign Countries.

No. 1484. November 1.—Commerce and Industries of Germany in 1901.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

Stamping Powders consist usually of some dry powdered color mixed with powdered resins—ordinarily, rosin, mastic, copal, sandarac, etc.—added to give it greater adhesiveness. The following are some of the current formulæ:

White—1 part rosin, 1 part dammar, 1 part sandarac, 1 part mastic, 1 part copal, and 3 parts white lead. This is much improved in action by the addition of 1 part each of borax and bronze powder.

Black—Equal parts of the resins given above, with Prussian blue, ivory black and bronze powder added.

Blue—1 part each of ultramarine Prussian blue, bronze powder, and add 1 part each of the resins named above.

The best plan is to powder each of the resins named above, mix them in equal proportions. This use as a stock, and to it add the colors as required. Other coloring matters than those named, and which may be used in the construction of stamping powders are the ochers, siennas, burned and raw umbers, chrome yellow, etc. These colors are sometimes applied by professional dressmakers, etc., moistened (not wet) with alcohol. We know of no formula for a stamping liquid, at least for one to be used in the way that the powders are applied—*i. e.*, by dusting over a perforated pattern and then fixed by passing a hot iron over them. If you want a liquid to be used with a hand-stamp (a marking liquid) indelible or delible, write again, and we will be happy to oblige you.—National Druggist.

The Following is said to be the process used in the Vienna shell button works to make mother of pearl iridescent. In a wide-mouth jar large enough to hold the shells, and fitted with a ground glass stopper, put as much ammonia water as will cover the shells. To this add silver chloride in powder until the liquid becomes saturated and a slight excess of the silver salt is established. Into this put the shell and, applying the stopper, set aside in a dark place for a few days. At the end of a week, more or less according to circumstances (the heat of the weather, density or porosity of the shell, etc.), remove the shell and place it, without washing, in the direct sunlight for two or three days. The play of colors is usually established in a few hours, but its permanency is made surer by a little longer exposure to the sun. As a general rule, one week's contact with the ammonia water, with two days' exposure to the direct light are all sufficient.—National Druggist.

If Gold and copper are melted together in any proportion and thoroughly mixed while fluid, the resulting bar or ingot will be uniform throughout in composition. But when silver is alloyed with copper only one proportion is known which will give a uniform casting. This proportion is 72 per cent silver to 28 per cent copper. With more silver than 72 per cent the center of a cast bar will be richer than the outside, which chills first; while with a less percentage than 72 per cent the center of the bar will be poorer and the outside richer than the average. This characteristic of silver-copper alloys is known to metallurgists as "segregation."—Mining and Scientific Press.

To Remove Rust from polished steel cyanide of potash is excellent. Soak, if possible, the instrument to be cleaned in a solution of cyanide of potassium in the proportion of one ounce of cyanide to four ounces water. Allow this to act till all loose rust is removed, and then polish with cyanide soap. The latter is made as follows: Potassium cyanide, precipitated chalk, white castile soap. Make a saturated solution of the cyanide and add chalk sufficient to make a creamy paste. Add the soap cut in fine shavings and thoroughly incorporate in a mortar. When the mixture is stiff cease to add the soap. It should be remembered that potassium cyanide is a virulent poison.—Mining and Scientific Press.

A Very Excellent Stove Dressing with two preparations is the following: Add soot or lamp black to water-glass (sodium or potassium silicate) until you have a mass of the condition of a thin syrup. With this dress your stove and let the dressing dry on—which will take about 24 hours. Next make a preparation of powdered plumbago in Soudan gum of about the same consistency. With this go over the first coating, and when nearly dry give the stove a good polishing with a stiff brush.—National Druggist.

There are a Number of Indelible Inks that contain no silver salt. One of the best of them is made as follows:

Copper chloride	1 part
Distilled water	3 parts
Liquor potassæ	q. s.

Dissolve the copper salt in the water, and to the solution add the liquor potassæ until a precipitate is no longer thrown down. Let stand until the precipitate settles, then decant or syphon off the supernatant fluid. Now add ammonia water a little at a time until the precipitate is dissolved. In order to give the liquid the consistency necessary to make it flow properly from the pen add 5 or 6 parts of dextrin, or more if necessary. Use a glass or quill pen and after the writing gets dry, pass a hot iron over it. Should the ink get thick from evaporation of the liquid add a little ammonia from time to time.—National Druggist.

To Remove Letters Burned in on China Plates and Slabs, without much injury to the glazing, rub the surface with a bit of pumice stone moistened with strong hydrochloric acid. It may also be done by rubbing with a cloth, wrapped on a stick to protect the hands, wet with hydrofluoric acid. The surface should be washed with a strong solution of sodium carbonate or bicarbonate and rinsed in clear water.—National Druggist.

Rancid Cod Liver Oil.—We do not know of any method by which cod liver oil which has become rancid can be restored. If it could be "washed" in any way the product would probably vary materially from the unadulterated oil, the composition of which, as you are doubtless aware, is very complex and but imperfectly understood. The oil, if not too rancid, might be utilized in dressing leather.—Drug. Cir. and Chem. Gaz.

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